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THE

INTELLECTUAL OBSERVER

REVIEW OF NATURAL HISTORY

MICROSCOPIC RESEARCH

AND

RECREATIVE SCIENCE

VOLUME XI.

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CONTENTS.

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FEBRUARY, 1867.

ANCIENT JEWELRY.

BY WILLIAM DUTHIE.

(With a Coloured Plate.)

ANTIQUARIANS, [illegible], learned, and indefatigable, have taken such pains to describe, among other ancient remains, the specimens of Egyptian jewelry which have been discovered in recent times, that it might appear unnecessary to treat of them further. After the elaborate explanations of Prisse d'Avennes, [illegible], Sir Gardiner Wilkinson, Dr. Birch, and others, of Egyptian [illegible], and the voluminous account given by Mr. Layard of Assyrian antiquities, there might appear to be a [illegible] to enlarge upon a subject [illegible] and ably treated.

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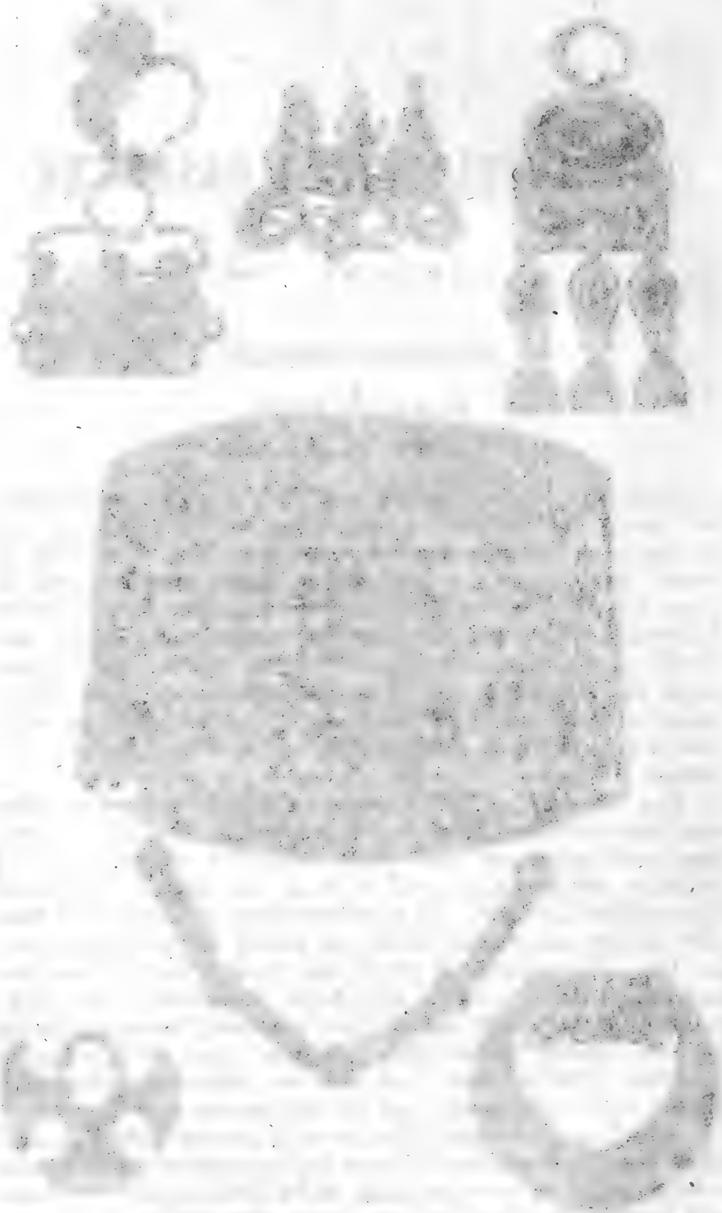


THE INTELLECTUAL OBSERVER.

FEBRUARY, 1867.

ANCIENT JEWELRY.

BY WILLIAM DUTHIE.

(*With a Coloured Plate.*)

Antiquarians, acute, learned, and indefatigable, have taken such pains to describe, among other ancient remains, the specimens of Egyptian jewelry which have been discovered in recent times, that it might appear unnecessary to treat of them further. After the elaborate explanations of Prisse d'Avennes, Daly, Sir Gardiner Wilkinson, Dr. Birch, and others, of Egyptian ornaments, and the voluminous account given by Mr. Layard of Assyrian antiquities, there might appear to be a certain presumption in any attempt to enlarge upon a subject which had been already so amply and so ably treated.

But, however carefully these ancient and interesting relics may have been described in an archæological point of view, they have never yet been dealt with in a practical way as pieces of workmanship; and it is in this light it is purposed to consider them here. It is evident that, so considered, they offer a very interesting field, not merely for speculation, but for the accumulation of proofs directly tending to show the progress made in the finer mechanical processes of art-workmanship in those early ages. To a workman, testing them by his own special knowledge, they may give evidence of a character different from, and not less interesting than, that offered to the antiquarian and the philosopher.

Acting upon this idea, the pieces of jewelry in the Coloured Plate have been selected as much for the purpose of illustrating certain points of workmanship, as for their marked character and beauty; to show, in fact, what advance the Egyptians and Assyrians had made in the arts of casting, chasing, soldering, stone-cutting, and other more technical processes in the manufacture of personal ornaments. It is believed that the objects chosen have not hitherto been engraved, and these

are represented in some cases in the state in which they were worn, instead of in their present dilapidated condition. With the exception of No. 1, an earring reduced from many examples of the same ornament on the colossal figures of the Assyrian bas-reliefs, the specimens shown are to be found in the cases of the British Museum. The very curious and beautiful collection of relics discovered at Thebes, and exhibited by the Pasha of Egypt at the English International Exhibition of 1862, would not have served the writer's purpose equally well, the majority of them not coming within the category of jewelry, being testimonial pieces, or symbols of office. These relics have been fully explained by Dr. Birch, and carefully copied and illuminated by Mr. Kiddle, of the War Office.* They are, it is believed, the most ancient specimens of art-workmanship in the precious metals in existence, dating from about B.C. 1800, or 3600 years ago. They will be again referred to.

It is surprising how far into the inner life of a people an examination of the works under review may lead; for the existence of one fact, proved to demonstration by the work itself, helps to establish other facts not so patent, and to suggest consequences of great interest, and of the utmost importance in determining the condition of art-manufacture at the period referred to. When, in opening some ancient British tumulus, the antiquarian unearths a rude ornament of gold, probably the breast or neck decoration of a chief, and finds it to consist of a simple thin plate, beaten into something like shape to serve its important purpose; having no mark of chasing-tool or graver, and, above all, no union by solder of two parts together, he must inevitably come to the conclusion that the goldsmith's art, at the time the ornament was made, must have been in the most primitive condition. It must be at once evident that here is simply a piece of hammer-work, in the making of which little taste and less skill have been exerted. On the other hand, every little addition to the naked piece of metal is not only a proof of a higher state of art in itself, but is evidence of progress in other directions of a kindred nature. Even so small a thing as a piece of wire is a sign of a decided advance in art upon the original crude plate; and, moreover, it shows progress in mechanical appliances; for the production of a piece of wire implies the possession of tools of an exact and complex character. Examined in this way, the process of manufacture of a simple piece of jewelry will serve to show the existence of other arts than that of the goldsmith.

* *Fac-similes of the Egyptian Relics Discovered at Thebes,* 4to, London, 1863.

The same antiquity cannot be claimed for the specimens chosen for illustration as for the relics of Queen Aah-hept; but the most recent example is of about the year B.C. 300. The Assyrian earrings, Nos. 1 and 5, are from Kouyunjik (Nineveh), of about 700 years before Christ. The necklace, No. 2, and the earrings, Nos. 4 and 7, are from Babylon, of probably a somewhat later date. The ring, No. 3, representing the figures of Serapis, Isis, and Horus, is of the Ptolemaic period, about B.C. 300 years. The bracelet, No. 8, is inscribed with the name of Namrut (Nimrod), an Egyptian prince of the twenty-second dynasty, from Sais, and therefore dates from about 500 years before Christ. The numbering has been arranged on the principle of taking the most simple forms and workmanship first, having some regard also to age.

The earring, No. 1, although not actually existing as a gold specimen, is found so repeatedly on the colossal bas-reliefs of the Nimrod collection, that it may be taken as a very common type of ornament, and although certainly elegant in form, is of very simple construction. It may have been cast solid, or struck with a punch in two pieces, and soldered together. It is scarcely probable that it was cast solid, as in that case its excessive weight would render it painful and even unsafe to wear. That the Assyrians certainly, and probably the Egyptians also, were in the habit of casting ornaments in metal, we have distinct evidence in the ring moulds discovered by Mr. Layard, and exhibited in the Nineveh collection. Not only have we there a mould for casting rings—not a mould of sand, as used in modern times, but of some chalky or clayey substance, in which the subject is cut in both halves of the mould, with a proper gate wherein to pour the melted metal, and radiating lines to admit of the escape of the air—but also small bells and weights, on which the distinct ridge left by the juncture of the mould is still visible. But even for so rude a piece of jewelry as a cast earring, some mechanical appliances are necessary beyond the mould and the metal. Some sort of furnace must have been erected, with probably wood for fuel, and an inflated pig-skin for a bellows. The workman must also have had crucibles, and some kind of iron pincers to lift his gold out of the fire.

But it is more probable that the earring in question was hollow—struck by means of a punch in two halves, and soldered together. This is undoubtedly the method pursued in the manufacture of the chain, No. 2; and adopting this conclusion, we must pre-suppose the carving or moulding of iron or bronze punches, and the knowledge of the several delicate operations which go to complete a soldered juncture of metals. We have no difficulty in determining the fact of the use of

carved punches in the manufacture of jewelry, for there are abundant evidences of it in the necklaces and other ornaments which are exhibited in the British Museum. One necklace of shells and cornucopiæ, placed alternately, is especially remarkable. It is of silver, and each kind of ornament is so exactly similar, that they must necessarily have been struck off the same punch. A bead necklace offers the same evidence; and it is not at all improbable that many of the aphes, cobras, scarabæi, and other symbolical ornaments which we find embedded in opaque glass, were struck from carved punches out of thin gold plate. The question then arises, how were these punches made? Were they also cast in moulds, say in bronze? Or were they forged, and worked up by file and graver into the required form? We have no evidence of the existence of a file at this period; and a file, besides that it must be of steel to be of any service, even upon bronze, is a really artistic production. There is no proof that steel was known at so remote a date, and the probabilities are against such a supposition. Cast iron is a modern invention; and regarding the matter from all sides, one is almost forced to the conclusion that these punches were cast in bronze, and finished for use by such cutting gravers or other tools as sharpened iron would furnish. The suggestion that these exactly similar ornaments might have been struck in dies offers many difficulties, for a die is an implement of manufacture much more difficult of production than a hand-punch.

Then arises the question of soldering. These duplicate pieces, struck with a punch, and made of an equal height by being snipped round their edges with shears, and rubbed down on a stone, must now be united by solder—not mere tin or pewter, but what is technically known as *hard* solder, *i.e.*, a metal only so far inferior by the addition of alloy to the metal it is to unite, that it is fusible at a somewhat lower degree of heat. But to solder in this way requires tools and appliances of a more delicate nature than we have as yet had to deal with. The preparation of solder itself, with its careful and minute proportioning of alloy, and its no less careful fusion—its thinning into plate, and its reduction by some means, by shears or by file, into small particles for use—requires considerable skill and indispensable tools. Then it is impossible to solder without some species of flux, to prevent the oxidation of the two surfaces to be united, during the process. What flux had the Egyptians or the Assyrians? It is a fact that in many parts of the East Indies to this day the native jewelry, although admirable in many points of execution, is not soldered together, but dovetailed, in a manner of speaking, by a series of minute "spitzens." The fineness of the gold employed admits of

this process, and the work does not depend for its strength upon its connected parts. The setting of their gems is invariably effected in this way, and with a little force may be lifted off bodily.

Borax is the immemorial flux of the jeweler all over the world, and it is not at all improbable that the Egyptians possessed this valuable medium; especially as, although now an artificial compound of its element, boracic acid and soda, manufactured to meet the demands of commerce, it is found, and was to be found doubtless in that remote time, as a natural production. But given the borax, the solder, the shears, or the file, we still require the charcoal, or some equivalent for it; and what is more, we still require the blow-pipe. His inflated pig-skin would not serve the Assyrian here; something more manageable was necessary—something which possessed both force and precision. It is held by scholars that Pliny (the younger) speaks of borax under the title of *chrysocolla,* and it is not at all unreasonable to suppose that borax, under this or some other name, was known at a much earlier date than his time. If the Egyptians had not discovered charcoal—and it is very possible they had, considering their necessarily constant use of wood—it would not be difficult to find some light porous stone to answer its purpose;* and the origin of the blow-pipe is so involved in obscurity, that there is scarcely any date too early to fix for its discovery. Moreover, although the blow-pipe of the modern chemist is a very scientific implement, it must be remembered that the jeweler's blow-pipe to this day is simply a piece of bent tubing, smaller at one end than the other. It is at least certain, then, that to solder, the ancients must have possessed some knowledge of alloy, and had for tools the blow-pipe, shears, or files, charcoal, or some analogous non-conductive substance, and must have known the valuable uses of borax as a flux.

This question of alloys is of more consequence than may at first sight appear; for, as a rule, the gold used in these ancient ornaments was in nearly a pure state; and it is not unreasonable to suppose that a knowledge of the ready fusion of certain other metals therewith might have tempted the workmen of antiquity to deteriorate the precious metal, as is systematically done in modern times. The universal use of fine gold suggests also one other solution of the solder difficulty: it is that fine gold, and fine gold alone, may, by the help of a flux, be "sweated," or brazed together instead of soldered; but it is a careful process, and can only be done with heavy pieces of work. It is true there are some examples of framework for

* Lava is an excellent substitute, but not likely to be found among the sands of Egypt.

inlaying in the cases of the British Museum which have a suspicious aspect, scarcely compatible with purity of material, but they are the exception to the rule; and, on the other hand, it is certain that many legitimate uses, of a less pure but harder gold, were altogether unknown. Thus, there are no joints to earrings, or spring fastenings to any of the ancient ornaments. The earloops are simply the attenuated ends of fine gold wires, which, once passed through the ear, were bent round till they held in their places, to be again straightened, should the earring require to be removed—a thing, it may be presumed, not often done. The bracelets, again, are permanent ornaments, and could scarcely have been removed without the aid of the jeweler.

No. 3 is a copy of a ring of the Ptolemaic period, and is made of woven wire, from which spring three cast and chased figures of Serapis, Isis, and Horus. Although generally effective, the workmanship of this ring is exceedingly coarse. It may be here remarked that nothing is so general as the introduction of chasing in all Egyptian jewelry, and indeed in all their metal work. There are even frequent examples of attempts at embossing, or *repoussé* work. This chasing, as a rule, is very rude, and consists of little more than outlines, but there are cases in which it is much more finished, and indeed very effective. The claw of a hawk in one of the upper cases of the Mummy Room of the British Museum is an example in point. The earring, No. 4, a relic of Babylon, is one specimen of modelling, casting, and chasing, although by no means one of a high order; and the Assyrian earring, No. 5, discovered by Mr. Layard at Kouyunjik (Nineveh), and which has a pearl at each end, is, no doubt, chased all round, and chased after the present method; that is to say, by being first filled with bituminous matter, in order to offer a sufficient resistance, and no more, to the blow of the chasing tool and hammer. The bitumen, resin, or gum with which the earring is now filled is probably an after arrangement, and in this respect it is similar to the loaded jewelry made even down to the present day in the East Indies. The earloop is conjectural, as the original one is lost.

The cylinder seal-ring, No. 6, is an admirable example of a type common among the Egyptians, and shows well the very general use among them of thin wire-work. Wire was made to serve as ornaments on plain surfaces in very many cases, and in its then use may fairly be taken as the origin of filagree, to which, in some instances, it bears a resemblance. The great use of wire is a fact to be noted, for the manufacture of this gold thread is by no means a simple process. It could not have been produced by mere hand labour, and must have

been drawn then, as now, through a graduated series of holes, made in some much harder substance than itself. Indeed, it seems difficult to conceive of a wire draw-plate in any less durable and compact metal than steel. A mere rude hole in a piece of iron would not answer the purpose, as it would rip and break the metal—the more so with so soft a metal as fine gold—and at the best would only produce wire of its own shape. A wire draw-plate is a very exact piece of workmanship, in which the holes are carefully graduated in size, so as not to produce too great a strain upon the metal at one time, and brightly polished so as to cause as little friction as possible, as well as to produce a wire of a perfectly round and smooth surface. Even when made of the finest steel, such plates wear rapidly, and the modern improvement is to substitute an eyelet of sapphire, or similar hard gem, in which the hole is made, instead of in the bare metal. Notwithstanding these difficulties, we must suppose that the Egyptians possessed some more or less perfect wire draw-plates, and, in addition, the vice and draw-plyers, in some shape or other, without which the first would be useless.

The consideration of the earring, No. 7, and the bracelet, No. 8, has been reserved to the last, because they present features of a character very different to the other examples.

The earring, which is from Babylon, is, to judge from its elaborate character, the most recent production of any here shown. It is not without a certain beauty of form, and is peculiar in the number of pieces of which it is composed, and in the fact that it is a "mounted" piece of work. Its component parts are neither cast nor struck with a punch, but made up in pieces from thin plate, soldered together, and filled with gum. It is made, in fact, in the same way as it would be made at the present day, with the exception of the gum; and could only be executed by a skilful hand with the aid of small round and flat plyers. Here, again, we are forced to the belief that such tools were known to the Babylonians at least, if not to the Egyptians. The lozenge-shaped stones are inlaid and flat, supported by the gum; the others are cut *cabochon*. The bracelet, although apparently a complicated piece of workmanship, is in reality very simple; and this again is "mounted" out of thin flat plate and chaneer, *i. e.*, hollow wire. Its great peculiarity is that it is jointed. The skill required, and the tools necessary for the drawing of wire, has already been dwelt upon, but the difficulty of making hollow wire from flat plate is even greater. Yet this is no new feature in Egyptian jewelry, for among the relics of Queen Aah-hept, B.C. 1800, 3600 years ago, is a bracelet having a joint containing fifteen divisions, technically called "knuckles;"

that is to say, seven divisions fitting into eight, like a well-made modern snuff-box. In both these bracelets there are two joints, and they are placed just so wide apart as to admit of the passage of the wrist, when the pin was again passed into the open joint, and the bracelet, or rather armlet, thus became permanently fastened.

There remain still two points to be considered; the manufacture of gold plate and the process of inlaying, of which latter art both the last described earring and the bracelet are good examples. It is difficult to understand how the gold plate, of which the Egyptians made so great a use, can have been produced, without the aid of some machinery of the nature of the flatting-mill of the present day. It is certainly possible to hammer fine gold into a thin sheet, but this can only be done by placing it between vellum, or some similar substance, and subjecting it to heavy blows by the hour. On the naked anvil it would be scarcely possible to produce an even surface, and then only by means of finely-polished steel hammers, which the ancients can scarcely have possessed. Yet it is easier to believe that they hammered their gold into plate on the anvil than that they possessed so complicated as machine as a rolling or flatting-mill.

As to the inlaying, Dr. Birch tells us, speaking of the relics of Queen Aah-hept, that "they are encrusted in a kind of *cloisonné* of opaque glass of blue and red colour, and are not enamelled. This latter class of work not being known prior to the Roman Empire." Again: "the principal substances used for this purpose by the Egyptians were lapis-lazuli, root of emerald, or green felspar, jasper, obsidian, and opaque glasses imitating them, and the delicate blue of the turquoise."

The bracelet before us appears to have been inlaid mainly with lapis-lazuli, alternating with thin plates of gold, also inlaid, and altogether representing that peculiar zigzag which was employed by the Egyptians to represent running water. The present drawing has been taken from the side, instead of the front, of the bracelet, in order to represent this more fully. The question now arises, by what means did the ancients cut their precious stones and coloured glasses into the required shapes? We know they were expert engravers on stone, but it is hardly to be supposed that they had invented the lathe, and engraved their figures and inscription by means of the points and small disks of the modern seal-engraver. Yet something of this kind they must have done; for, assuming that their seal-devices and writings were cut by small chisels, or by friction with the points of harder stones, which is possible, but extremely laborious, how could they have shaped their seal-stones for setting or for inscription without a lapi-

dary's mill? Even more necessary would such an implement be for the purposes of inlaying; for granting that the Egyptian or Assyrian workmen were able, by some rude means, to fit their separate pieces of mosaic into the places prepared for them, how would they level the whole surface, as they have undoubtedly done, smoothing it and polishing it to a high degree, without the action of some machine, revolving with rapidity, which should make a clean sweep of it?

It is impossible to answer these questions. The utmost we can do is to make careful guesses from visible facts. It may be said that it was quite possible for the ancients to effect all they did in the manufacture of jewelry without any of the tools of the modern art workman, given the requisite time and patience. Doubtless, this is one solution of the difficulty; for we know from later works, executed under difficult circumstances by prisoners and others, that it is almost impossible to impose too hard a task on the ingenuity and perseverance of man. But then, in such cases, time and labour must count for next to nothing.

Whatever the implements at his command, it is clearly evident that the Egyptian and the Assyrian workman could melt and alloy the precious metals; could flatten them into thin plate, draw them into fine wire, prepare punches to strike them into ornamental shapes, and solder these shapes together. Further, that he could chase and engrave; that he could "mount" the metal he had prepared into any form his taste might suggest, and could inlay his mounted work with coloured glasses and stones. Also, that he could make moulds, and cast solid ornaments, could gild metal, and weave wire-chains. Lastly, that he could cut, engrave, and polish the hardest stones; could set them in rings and as amulets; and that his taste had in it so much of vitality that it lives and inspires his successors even to this hour. In fact, we may deny this ancient craftsman the possession of many tools which appear to us indispensable at the present day, to effect the same object, but in doing so we only acknowledge, and must the more admire, his skill and his perseverance.

TRIAL OF THE PYX.

In the days of our remote ancestry, when mints existed in different parts of Great Britain, and were superintended by various individuals known as moneyers, it was no doubt necessary that frequent examinations of the various coins issued from those establishments should take place. Such examinations constituted valuable checks upon those who were engaged in the manufacture of the State monies, and were a guarantee to the public that those monies were of the legal standards of weight and of fineness. For many centuries, however, trials of the Pyx took place within the mints themselves, and were conducted by officials connected with the mints. They were made at stated intervals, usually once in every three months, and they came to be considered part and parcel of mint duties. It is not essential for our present purpose to inquire into the mode of operation pursued in those primitive days of English minting, and, if it were attempted, the task would prove to be one of extreme difficulty, from the fact that the sources of information are few and unsatisfactory. We may, therefore, more profitably consider the subject of the trial of the Pyx from the period when, according to the best historical data, it became a public ceremony, and when our monarchs not unfrequently took part in it. Ruding, in his elaborate and erudite work known as the *Annals of the Coinage of Great Britain and its Dependencies*, fixes this time very precisely, for he states that the first public trial occurred on the 24th February, 1248, the 32nd year of Henry III., before the Barons of the Exchequer, the jury being composed of twelve discreet and lawful citizens of London, with twelve skilful goldsmiths of the same place. The first known writ for such a trial is dated, nevertheless, at a later period, namely, 1281, and, in the reign of Edward I., and it is pretty clear that the trial of the Pyx,* or Mint-box, as now practised, and as against the Master of the Mint, was really instituted in the year last named. It was certainly not till 1279 that the royal mints were consolidated under one mint master, and that the latter became party to an agreement with the king (Edward I.) for the execution of the coinage of the realm, and thus made himself individually responsible for its genuineness. An ordinance was passed in the same year called Rotulus de Monetâ, or the Roll of the Mint, and intended to regulate the proceedings there. A copy of this ordinance exists, and it ordains: 1. That a standard should be made and kept at the Exchequer, or where the king wished, and that the coin should

* Derived from the Greek Πυξις, a box.

be made according to the standard of identical goodness. (Premeurement qe hom doit fere un estandart qe doit demorer al Eschekar, ou en quel lieu qe nostre Seignor le Roy vodra. Et selone la forme del estandart serra fete la moneye, et de tiel bonte come lestantar). In the sixth clause of the Ordinance reference is distinctly made to a Pyx-box, in which was to be deposited a sterling coin out of every ten pounds weight struck for the purpose of making the assay or trial. It also gives explicit instructions as to the custody of the keys of the box, of which there were to be two, one for the Master, and one for the Warden of the Mint.

The system of holding trials of the Pyx, obtained with more or less regularity, once in three months, until the reign of Queen Elizabeth, and Ruding quotes the following from an account of such proceedings which took place in her reign—"And uppon reasonable warning thereof given, it (the Pyx-box) shall be op'ned once in three monnethes before some of the Queen's Counsell assigned, in the presence of the said Warden and Master; and ther shalbe maid assaies as well of the finness as of the waight of the said monies of gold and silver by enie meannes in the said box."

Pending the troublous times of Charles I., trials of the Pyx were held at very irregular and uncertain periods, the probability being that they were deemed of much less consequence than the trials of strength continually waged between that unhappy sovereign and his parliamentary antagonists.

During the Commonwealth it is believed that only one public examination of the coinage took place, and that a long time after Cromwell's accession to supreme power, namely, in 1657. The warrant for this is still extant, and, since, it is very brief, it may not be uninteresting to quote it entire. It runs as follows:—

"Oliver P.

"Whereas, amongst other weighty affairs of the Commonwealth, the care of assaying and trying the monies thereof by the standard of England, according to the ancient custom of the realm, is not the least. We, judging it necessary that the trial and assay of the said money be forthwith made, do therefore hereby signify such our will and pleasure to be, commanding you forthwith to cause a trial and assay to be made of the Pyx, now being in the Mint, within the Tower of London, by a Jury of Goldsmiths of our said City of London, of integrity and experience, to be empannelled on a day certain to be by you in that behalf appointed, in the place accustomed, within our Palace of Westminster, and that the Lords Commissioners of our Treasury, the Justices of the several Benches, and Barons of the Exchequer, or some of them, be then there present and

counselling and assisting you in the execution of our service."

"Given at Whitehall, the 9th day of November, 1657.

"To our trusty and well-beloved Nath. Fiennes and John Lister, Lords Commissioners of our Great Seal of England."

From the period of the Restoration to the time of Her Majesty Queen Victoria, trials of the Pyx have occurred at very uncertain intervals, generally, however, on the appointment of a new Master of the Mint* the ceremony is performed, it being held desirable to relieve the retiring officer of all responsibility, and to transfer it to his successor. No other specific rule exists either on the authority of a Royal Warrant or an Act of Parliament for regulating the time when such trials shall take place. The practice, however, of late years has been to determine this point by the contents of the Pyx-boxes themselves. When those receptacles become filled with coin, it is physically essential that they should be emptied, and, in order to accomplish this feat, the cumbrous machinery of the State has to be put in motion.

There are two Pyx-boxes deposited in a strong room at the Mint, and the rapidity, or otherwise, with which they are charged, depends on the activity of the stamping presses of the establishment. One of the boxes is for the receipt of gold and the other of silver coin. Each of the boxes is furnished with three distinct locks, and the keys of which are retained respectively by the Master, the Deputy Master and Comptroller, and the Queen's Assay Master. In the boxes a single coin from every journey weight† of gold or silver money transferred to the Mint office from the coining department is deposited. At the close of each day's weighing of coins at the central office of receipt and delivery, the Pyx coins, corresponding in number with that of the journeys passed through the scales, are put up in a paper parcel, and sealed by at least two of the officers just mentioned. They are then placed in their sacred prisons, and securely locked up until the day of trial. It may be stated, in passing, that other pieces are retained day by day from the current work, and tested both as to weight and fineness by the Deputy Master and the Assayer. These operations are known as the Mint Pyx Assay, and they are always completed before the bulk of coin to which the trial pieces pertain are forwarded to the Bank of England.

* The office is now held as a life appointment, and has been so held since 1851. Formerly it was a ministerial post.

† A "journey" of gold consists of 180 ounces, or 701 pieces (sovs.), and a journey of silver of 720 ounces, the number of pieces being dependant on the denomination of coin. The word journey is believed to be a corruption of the French word *journèe*.

Whilst treating of this part of our subject, it will not be out of place to mention that each pound troy of gold is coined into $46\frac{29}{40}$ sovereigns, and that the standard degree of fineness of the coin is twenty-two carat, that is, twenty-two parts fine gold and two parts of alloy, in accordance with the Act 56 Geo. 3, c. 68, s. 11. The pound weight of silver is coined into 66 shillings, the same rate being observed with all other denominations of silver money, its standard degree of fineness being eleven ounces two pennyweights of fine silver, and eighteen pennyweights of alloy, in pursuance of section 4 of the same Act of Parliament.

Having thus explained, with, it is hoped, as much distinctness as will make the arrangements intelligible, the mode of charging the Mint Pyx-boxes, let us proceed to detail the ceremonial processes intermittently practised for the discharge of their precious contents.

The repletion of the boxes being officially made known by memorial to the Treasury, the Chancellor of the Exchequer moves Her Majesty in Council, and an Order in Council, appointing an early day for the trial of the Pyx, is the result of this action. The Chancellor of the Exchequer also issues his warrant to the Comptroller General of the Exchequer, directing that officer to produce, at the specified date, the standard trial plates* and standard weights in the custody of the Exchequer office. Immediately before the trial the Pyx chamber is formally opened by officers of the Treasury and Exchequer, and the plates, removed from their sealed depositories, are forthwith curtailed to a slight extent of their fair proportions, the cuttings being reserved for assay in the manner presently to be mentioned.

Simultaneously with these proceedings, notice is given by the Treasury to the Lord Chancellor and to the Queen's Remembrancer of the day of trial. The great law officer next issues a precept to his loving friends the Wardens of the Mystery of Goldsmiths of the City of London, and requiring them to nominate a jury of sufficient and able freemen of the company, "skilful to judge of and present the faults of the coins, if any be found," and to be present at the day and hour appointed for their trial.

When the fell moment has arrived, the various persons whose duty it is to sit in judgment upon the imprisoned coins assemble at the office of the Comptroller General of the Exchequer, in a room appointed for that purpose; those persons, according to a recently published official paper, to which further reference will have to be made presently, comprise

* For full description of standard plates, *vide* INTELLECTUAL OBSERVER, vol. vi., page 82.

"Certain members of the Privy Council, who constitute the Court, with the Lord Chancellor for president; the Comptroller General and other officers of the Exchequer, the Serjeant-at-Arms attending the Great Seal, the Queen's Remembrancer and his officers, the Master of the Mint, the Queen's Assay Master, and other officers of the Mint, the jury, freemen of the Goldsmiths' Company, including in their number their Assay Master, together with the Clerk of the Goldsmiths' Company and their attendants." A goodly array of authorities, and no doubt the Serjeant-at-Arms attends with a view to the capture of the Master of the Mint, who is also on his trial, should the jury find an adverse verdict, and declare that the Pyx coins are below legal standard.

The oath is next administered, and it is as follows: "You shall well and truly, after your knowledge and discretion, make the assays of these coins of gold and silver, and truly report if the said monies be in weight and fineness according to the Queen's standard in her Treasury for coins; and also if the same monies be sufficient in alloy, and according to the covenants comprised in an indenture thereof bearing date the 6th February, 1817, and made between His Majesty King George III., of the one part, and the Right Hon. William Wellesley Pole, of the other part. So help you God." After the foreman of the jury has duly taken this oath, and "kissed the book," it is administered to his fellows in batches of three or four at a time. Then the work of examination is really about to commence, and the jury return to Goldsmiths' Hall, having in their custody the portions of the gold and silver plates before named. The Pyx-boxes of the Mint have already reached that place, and the first work of the jurors is to count out and weigh their contents. They then select from the whole mass of coin a certain number of pieces of each denomination, and melt them in the ordinary way into ingots of gold and silver. From the corner of each ingot a small piece is cut off, and then the ingots themselves are flattened by hammering and lamination into straps or bands of about $\frac{1}{32}$ of an inch in thickness. From the straps pieces are punched and weighed with the closest accuracy. The cuttings are put into paper envelopes, upon which their respective weights are noted to the one-thousandth part of a grain. Then follows the assay, which is effected by "cupellation."* Other jurors busy themselves with the test plate slips and cuttings, and effect *their* assay by precisely analogous means. Finally, reports are made by the two sets of operators—the proceedings

* *Cupellation* is the art of refining gold or silver by means of a cupel, which is a small vessel that absorbs metallic bodies when changed by heat into fluid. The operation is explained at length in all encyclopædias of science.

lasting several hours—and those reports are compared. To the credit of the Mint, it must be said that the jurors' reports have seldom or never disagreed to an illegal extent, certainly they have not since the year 1290, and, consequently, no Mint Master has ever, from such a cause at least, been carried off by a Serjeant-at-Arms.

The true standards of weight and of fineness of all gold and silver coins issued from the Royal Mint have been already mentioned, but it must be observed that a certain amount of latitude is allowed by law in both those respects. It has been found practically impossible to manufacture metallic money in large quantities, and with any degree of rapidity, in such a way as to insure the perfect uniformity of each individual coin with the exact and true theoretical standard prescribed. In spite of the most rigid attention in the admixture of the alloy with fine gold or fine silver, there will occur deviations in the ultimate degree of fineness of different parts of the resulting metal. So, again, with regard to weight. However mathematically precise the mechanism necessary for the production of coin may be in its action, there is sure to arise variations in the weight of the planchets cut out for stamping. This latter result arises mainly from the differing density of the metal operated upon. Legal allowance is made for these inevitable aberrations, from which even the trial plates are perhaps not entirely exempt. This allowance is termed in the Mint indenture the "Master's remedy." This remedy has varied in extent at certain periods, but at this moment is, so far as gold is concerned, $\frac{1}{20}$ of a carat, or twelve grains upon each pound troy, both as respects fineness and weight. The remedy allowed upon silver employed in the coinage is one pennyweight per pound troy, for the standards both of weight and fineness. Beyond these limits it may be said to be impossible for any Mint coin of gold or silver to escape the Mint walls. The trial of the Pyx is supposed to demonstrate this fact, and to give it the stamp of extra moral, and independent official certainty.

We may now give some particulars as to the most recent public trial of the Pyx, with the finding of the jury on that occasion. The trial took place on the 19th of January of the past year, and was conducted precisely in the way indicated above. The monies thus examined comprised Pyx-pieces, culled as described from the daily productions of gold and silver coin at the Mint between the first day of January, 1861, and the 31st day of December, 1865, both days inclusive. The jury, at the close of their investigation, stated that they found in, and took out of the Pyx-box, gold coins consisting of 45,482 sovereigns, or twenty shilling pieces, and 4348

half-sovereigns, or ten shilling pieces, coined after the rate of £46 14*s*. 6*d*. (or £46·725) to the pound weight troy, making, by tale, £47,656, and weighing 12,239·713 ounces; but which, at the rate of £46 14*s*. 6*d*. (£46·725) to the pound weight troy, should weigh 12,239·102 ounces; and, having taken 224 of the said sovereigns, and 39 of the said half-sovereigns, being in tale £243 10*s*. (or £243·500), and in weight 62·533 ounces, did find the same to be, by the assays and trial thereof, agreeable to the standard trial plate of gold in Her Majesty's Exchequer, dated the 31st day of October, 1829. The *precise* results of the inquiry may be summarized as follows: The Pyx gold monies amounted by tale to £47,656, and by the theoretically true standard should have weighed 12,239·102 ounces; they were really found to weigh 12,239·713 ounces, being in excess 0·611 ounces. The aggregate allowance for this quantity of coin is 25·498 ounces, either above or below the standard weight, and it is seen, therefore, that the Pyx pieces were within remedy to the extent of 24·887 ounces, or 2·396 per cent. of the deviations allowed.

With regard to the silver coin so tested, the jury reported that they found in, and took out of the Pyx-box 2936 florins, 3367 shillings, 1006 sixpences, 10 fourpences, 545 threepences, 10 twopences, 10 threehalfpences (circulating in the West Indies), and 30 penny pieces (Maunday money), coined after the rate of 66 shillings to the pound weight troy, and making by tale £494 7*s*., and weighing 1796·943 ounces, but which, at the rate named, should weigh 1797·637 ounces; and, having taken of the said silver coins 42 florins, 60 shillings, 2 fourpences, 26 threepences, 1 twopenny piece (Maunday), 4 threehalfpenny pieces, and 2 pennies, being in tale £8 7*s*. (or £8·350), and the weight, 30·363 ounces, did find the same to be, by the assays and trials thereof, agreeable to the standard trial plate of silver in Her Majesty's Exchequer. The remedy on such a quantity of coin is 7·490 ounces, but, as their lack of the true weight was only 0·694 ounces, it follows that the silver Pyx was within legal allowance to the extent of 6·796 ounces. The foregoing verdict, accompanied by certain ancient verbiage, here purposely omitted, having been delivered, the business proceedings of the day terminated, the trial plates were deposited in the cloisters of Westminster, and the Pyx-boxes were returned to the Mint, there to remain until the next trial of the Pyx.

The court and jury had a pleasant duty to perform in the evening, for they then partook of a sumptuous banquet in the magnificent Hall of the Goldsmiths' Company, a practice which of late years has been regularly adhered to on similar occasions, and which forms an agreeable item in the programme beyond doubt.

The ceremony of the trial of the Pyx has thus been explained as explicitly as the limits of one paper in the INTELLECTUAL OBSERVER would allow, but the questions remain to be asked, Is it desirable to perpetuate the venerable performance? or has it not become an obsolete form, which might as well die out? We are disposed to think that the latter question should be answered affirmatively, and this, notwithstanding the publication of an elaborate defence of the practice in the form of a Parliamentary paper, written mainly by the Chief Clerk of the Exchequer.* Many cogent reasons might be assigned for the conclusion we have arrived at on the question of the retention or abolition of the trial of the Pyx, and for our adhesion to the opinion that it has become an utterly useless, as it is a troublesome and costly proceeding. One or two of those reasons may be introduced before leaving the subject. The first is that as the business of the Mint is at present conducted, it is quite impossible—physically and morally impossible—for any gold or silver coin "out of remedy" to leave the Mint, or to be deposited in its Pyx boxes. The operations of every department of that establishment are so governed by checks, as that no such thing can happen. The next is that if defective coins—defective as regards standard of weight or of fineness—did escape, a trial of the Pyx to which they belonged, five or six years after they had gone into circulation, would be of no earthly use, except to excite the risible faculties of the public generally. The truth is that the daily trials of the Pyx at the Mint are, in our time, of infinitely more service than the irregularly performed ceremonies at Westminster or elsewhere, and which depend not upon necessity or rule, but on the area of the Pyx boxes. The only really good argument in favour of its continuance is, that it is the prelude to a dinner at a City hall. In all other respects it is little other than a solemn farce. It is probable that the question of the continuance of the trial of the Pyx will be fully discussed during the next session of Parliament, and we have the satisfaction of thinking that a contribution is here made towards a more perfect knowledge of the subject, and which may lead to a satisfactory solution of the problem. The fact that the ancient office of the Exchequer is itself on the eve of being abolished, as a distinct department, and that the duties relating to the Pyx trials will at all events have to be transferred, seems to suggest *the period* for discontinuing those duties entirely, as apart from the Mint.

* Mr. H. W. Chisholm.

ON THE FORM, GROWTH, AND CONSTRUCTION OF SHELLS.

BY THE LATE DR. S. P. WOODWARD, F.G.S.

Edited from his MSS. by Henry Woodward, F.G.S., F.Z.S., of the British Museum.

(*Continued from page* 253, *Vol.* x. *November*, 1866.)

The Siphons.—As nearly all bivalves live buried in the sand or mud, they are furnished with more or less elongated tubes, one of which is called the inhalent and the other the exhalent siphon (see Woodcuts, Figs. 10, 12, 14, and 15).

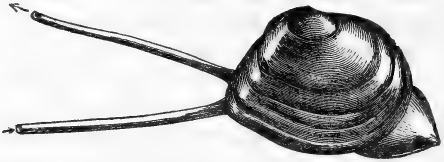


FIG. 14. *Tellina solidula* (British).

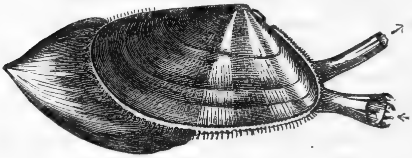


FIG. 15. *Donax anatinus* (British).

Both having the foot protruded ; the arrows indicate the inhalent and exhalent siphons.

In those bivalve forms, like *Mya*, *Lutraria*, and *Anatina*, in which the valves do not perfectly shut in the animal, the siphons lie side by side, and are enclosed in the epidermis, which is prolonged, and forms a strong horny envelope around the shell and respiratory tubes. In certain boring and burrowing bivalves, as *Gastrochæna*, *Clavagella*, and *Teredo*, the shell does not increase with age, but the siphons secrete a shelly tube in which the soft parts of the animal are incased, and the minute valves of the young mollusk are seen embedded in the wall (see Coloured Plate, Fig. 13, Vol. x., p. 241, the "watering-pot shell," *Aspergillum vaginiferum*, the minute valves are seen near the lower extremity of the tube).

The *External Ornamentation* is another very apparent cause of the immense variation in the form of shells. This is due almost entirely to *periodic growth.* All mollusca, except the Argonaut, possess a minute rudimental shell before they are

hatched, which forms the apex or the umbo of the adult shell. But the shell, in its subsequent growth, frequently differs entirely from the embryo, both in form and colour. The shell of the infant *Cymba olla* is large and very irregular; in *Magilus*, and in *Patella*, it is spiral, but afterwards becomes tubular in the former, and tent-shaped in the latter. In the *Nudibranchiata* the shell of the embryonal mollusk is shed at an early age, and never replaced. Many of the minute shells found, as well fossil as recent, are probably only the fry of larger species, and require great caution in their determination.

The size of the adult shell is often characteristic of the species, but this is by no means uniform. The author has frequently seen specimens of *Cypræa turdus*, equally adult, measuring three-quarters, to one and a half inches, but the dwarf varieties are more common than the giants.

Law of Alternation and Periodicity.—In summer and winter land-snails cease to grow. The snails of the first year, hatched in the spring, usually attain half their growth in the autumn of the same year, and their maturity in the following spring. There is always a stronger line of growth or conspicuous mark on banded and garden snails, and in some a rib inside strengthens the rim of the half-grown shell.

In the writer's cabinet are two examples of *Helix aspersa*, the common garden snail, which are grown together. They had passed the winter months hybernating in the same retreat, the one being probably nine months old, the other fifteen months. The younger snail died, having, no doubt, been killed by the frost; the survivor crept forth in the spring, bearing his deceased but irremovable companion, firmly cemented upon his back. As the living snail continued to grow, he came in due course around his own axis to the spot where the dead snail still remained fixed, and being unable to disconnect it, he formed his new shell over his attached companion, and thus in death they remain united.

Sea-snails certainly take many seasons to attain maturity, even supposing them to grow twice a year. Dredging is usually only carried on in the spring and summer months; yet a large proportion of the mollusca taken are immature. *Eulima* grows a whorl at a time, then thickens its lip and rests; ultimately a straight line is found down one side of the shell, caused by the coincidence of these "rests." In *Ranella* the line of "rests" is also coincident; but as it only grows half a turn between each, there are two rows down the spire. In *Triton* (the shell usually represented being blown as a horn by sea-deities attendant upon Neptune and Amphitrite) the "periodic mouths" form alternating nodes up the spire to the slender apex. The *Muricidæ* are extremely varied in form by

having three rows of spinous fringes produced at nearly coincident intervals on each whorl of the shell, and becoming longer with age. "Venus's comb," *Murex tenuispina,* is an instance of this, the canal of the shell being produced to twice its length, and fringed with three rows of long and slender spines, slightly curved, like the teeth of a harrow. In the Coloured Plate we give a less common example, the *Murex adustus* (Coloured Plate, Vol. x., p. 241, Fig. 7), the spines of which are extremely picturesque, reminding one of the branching fir-tree.

In the "Wentle-trap," *Scalaria pretiosa* (see Plate, p. 21, Fig. 2), the periodic mouths encircle the shell-whirls, which are sometimes separate, and contribute not a little to the beauty of this once costly conchological treasure.

Just as with the growth, we see periodic markings on the external surface of the shell, so also in the section of almost any spiral shell we see a repetition of folds around the *columella,* or internal pillar of the shell, and sometimes upon the sides of the whorls (see Plate, Vol. x., p. 245, Figs. 6 and 8).

But the most marked character in *adult* univalves is produced by the formation of a final aperture and ultimate lip to their shells. This is well seen in the "spider," or "scorpion-shell," *Pteroceras,* from China, in which the apex of the shell is concealed in a long, claw-like spine, while six others extend from the outer lip, and the canal is curved to correspond with the apical spine.

In the great fossil *Rostellaria ampla,* from the middle eocene formation of Barton, Hants, the adult animal puts forth a widely expanded lip, as broad as one's hand. In *Vermetus* (Fig. 9, Coloured Plate, Vol. x., p. 241) and *Siliquaria* (Fig. 10) the whorls become disunited in age. In *Aspergillum* (Fig. 13), each periodic growth is marked by an additional frill to its siphonal tube; and when adult, it forms the curious perforate disk from which it obtains its name.

The "Cowry" (*Cypræa*), so common an ornament upon the mantel-piece, when young, is a thin spiral shell; but when it becomes adult, it thickens its aperture enormously by repeated depositions of shell-matter, until we fail to discern the apex at all. In the Plate, Vol. x., p. 245, Fig. 7, is represented a transverse section of *Cypræa turdus,* which well illustrates this peculiarity. See also figure of *Cypræa guttata* (Plate, p. 21, Fig. 4; drawn from a specimen in the British Museum valued at £40).

But perhaps the most marked change which takes place in adult shells is to be seen in certain land-snails belonging to the *Helicidæ.* In *Gibbus Lyonetti,* from Mauritius, the shell, after forming five ordinary convolutions, suddenly makes a complete double in its growth, and remains hump-backed for

Fig. 1. Conus gloria maris.

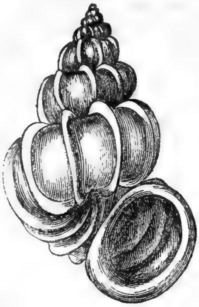


Fig. 2. Scalaria pretiosa.

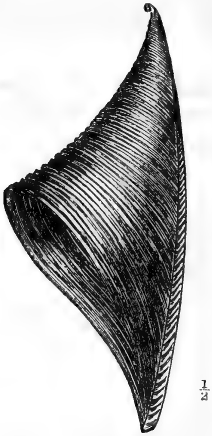
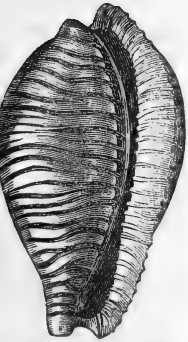


Fig. 3. Carinaria vitrea.
China.



ig. 4. Cypræa guttata.

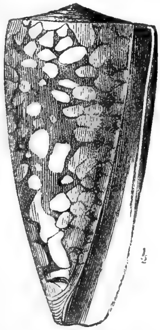


Fig. 5. Conus nobilis.

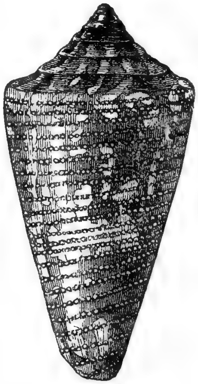


Fig. 6. Conus cedo-nulli.

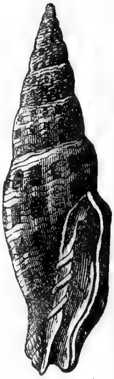


Fig. 7. Mitra
Stainforthii.

g. 8. Mitra zonata.

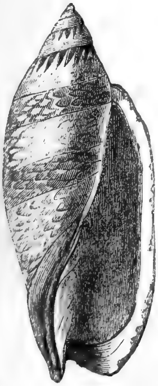


Fig. 9. Voluta reticulata.
Swan River.

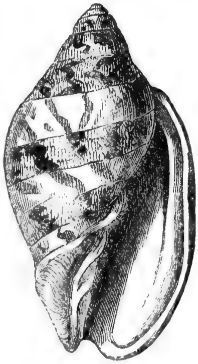


Fig. 10. Voluta piperita.

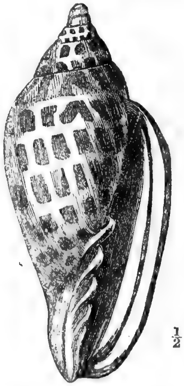


Fig. 11. Voluta Junonia.
Gulf of Mexico.

FORMS OF MARINE SHELLS.

the rest of its days. We have figured in our Coloured Plate, Vol. x., p. 241, the upper and under view of a still more eccentric land-snail, the *Helix* (*Anastoma*) *globulus* (Figs. 4 and 5), from Brazil. This snail, after growing like an ordinary *Helix hortensis*, or *arbustorum*, suddenly pulls up, and, twisting his mouth up tight, produces the aperture on a plane with the spire!

Many of these land snails not furnished with *opercula* fortify the entrance to their shell by secreting a number of shelly plates, or teeth, around the aperture (see Coloured Plate, Vol. x., p. 241, Fig. 4), so as to lead one to marvel how the occupant of the shell managed to get in or out of his own house, and still more how the eggs were excluded. In operculated *Gasteropoda* (snails with a door to their houses), the growth of the shell necessitates a corresponding enlargement of the lid, or operculum; this constantly receives fresh shelly layers from the mantle of the animal, and in those snails with a closely-fitting operculum the growth is always in proportion to that of the shell. Snails having spiral opercula (see Coloured Plate, p. 241, Fig. 3, and Plate, p. 245, Vol. x., Figs. 1 and 3) rotate their operculum slowly as they grow, so that the addition always takes place along that portion of the margin which is next the *columella*, or axis of the shell. The interior and exterior surface of shelly *opercula* are very diverse, as seen in Figs. 1, 2, and 3 of the Plate, Vol. x., p. 245.

It is absolutely essential that the mantle should cover any part of the shell to which additions are required; any injury therefore beyond the reach of the mantle externally, must be repaired from the interior. This will explain why the broken apices of univalves, and the eroded umboes of the river-mussel, are never repaired externally, but always by deposits within the spire or the valves of the shell.

In the Coloured Plate which accompanied the earlier pages of this article, in November last, p. 241, we gave a number of illustrations to show the extreme variation in the form and growth of shells. In the plate which accompanies the present part, at p. 21, we offer an additional series, in which we not only notice variations in form, due to growth, etc., but also a great variation in ornamentation resulting from colour. There are few shells more persistent in form than are the "Cowries" (*Cypræa*) and Cones (Figs. 1, 4, 5, and 6); but the former numbers upwards of 150, and the latter more than 200 species, chiefly distinguished by the diversity of their colouration. The Mitras (Figs. 7 and 8) are even more numerous than the Cones (having some 400 species), many of which are striking illustrations of brilliancy of colour.

The Volutes (Figs. 9—11), though a less numerous generic division, contain nevertheless, many shells remarkable for

variety and richness of painting. These four genera include probably the rarest and most costly shells that are known, and few persons, we think, can fail to appreciate their beauty.

Yet the shell in the Cowry and Volute is concealed within the folds of the mantle; in the Cone, it is covered by a thick and rough epidermis, which has to be removed before its hidden beauties are discovered. "God's works," writes Prof. Forbes,* "are never left unfinished. None is too minute for the display of infinite perfection. The microscope has exhibited to our wondering eyes beauties of structure that have been concealed from mortal sight for long ages. It would almost seem as if only glimpses of those excellencies of creation are permitted to man to behold, whilst the full contemplation of such wondrous charms is reserved for immortal and invisible admirers."

But living mollusks not only secrete shell-matter; they have likewise the power to absorb the internal convolutions and *columella* of their shells, either completely, or until it is reduced to the thinnest film. The cone removes all but a paper-like portion of its inner whorls (see Plate, Vol. x., p. 245, Figs. 4, 5, longitudinal and transverse section of *Conus tesselatus*), and the *Cypræa* (Fig. 7) often goes still further in removing all trace of its axis.

The *Olivæ* and *Neritidæ* likewise remove the internal spiral column of their shells; and the *Auriculidæ*, among land-snails, do the same.

This power of dissolving shell is also used by the *Muricidæ* in removing those external spines which would interfere with the continued growth of the shell.

Hermit-crabs in like manner increase the accommodation of their houses by breaking away the internal axis and convolutions of the shell they inhabit. In the writer's cabinet is a *Bulmius* shell from the Antilles, inhabited by a land hermit-crab (the *Cenobita Diogenes*), which has been completely cleared from its columella, and made into one commodious chamber within.

Nearly all the peculiarities in the form of shells relate to some special function or habit of life of the animals which inhabit them.

Perhaps one of the most important functions which requires to be provided for is that of respiration. We have already seen that in many of the burrowing bivalves, the siphons cause the shell permanently to gape at the end to accommodate them. Again, in the univalves, the aperture of the shell is usually found to be characteristic of the division to which the animal belongs; the mouth being entire in most of the

* *British Mollusca,* Introduction, p. xv.

vegetable feeders (or *Holostomata*) (see Coloured Plate, Vol. x., p. 241, Figs. 2, 3, 4), and notched, or produced into a canal in the carnivorous families (or *Siphonostomata)* (see same Plate, Fig. 7—and Plate, p. 21, Figs. 7—11). But this canal, or siphon, is *respiratory* in its office, and must not, therefore, be taken as a *certain* indication of the nature of the animal's food. Thus, for example, *Scalaria pretiosa* (Plate, p. 21, Fig. 2) has a holostomatous aperture, but is known to be carnivorous in its diet. If we refer back to the figures of the dog-whelk (*Nassa reticulata,* Vol. x., p. 247), and the common whelk (*Buccinum undatum,* p. 248), we shall see the long incurrent siphon protruding from the canal of the shell and turned upwards. Into this tube the water passes, and enters a vaulted chamber (formed by an inflection of the mantle of the animal), which contains the pectinated, or plume-like gills. After traversing the length of the gills, it returns and escapes through a posterior siphon, generally less developed than the anterior one, but very long in *Ovulum volva,* and formed into a tube in *Typhis.*

The object of the long siphon in the whelk is to enable it to respire freely while burrowing in the sand in search of its prey—the poor defenceless *Mya,* and other bivalves. The *Ampullaria* has also an extremely long siphon, which enables it to breathe, when it retires deep beneath the river mud during the dry season.

In the ear-shell (*Haliotis*), found living on the rocks at low-water in the Channel Islands and elsewhere, and so common a mantel-piece ornament, on account of its pearly interior; the excurrent siphon is accommodated by a hole near the lip of the shell, repeatedly renewed with the growth of the animal. In the key-hole limpet (*Fissurella*), the anal siphon passes through the perforation on the summit of the shell.

In *Siliquaria* (see Coloured Plate, Fig. 10, Vol. x., p. 241), the notch for this siphon remains unclosed, so that as the shell grows, it prolongs the fissure through the whole length of its tube.

In those mollusks whose shell is reduced to a mere rudimentary organ, we still find that its design and object is, primarily, to protect the heart and breathing organs. Thus, in *Testacella* (Fig. 4, Vol. x., p. 245) it covers the *hemal,* or heart-region, and again in the keel-shell, *Carinaria* (see Plate, p. 21, Fig. 3), in which the shell is less than one-seventh part the size of the body of the animal, its only use is to cover the branchiæ.

Lamp-shells (*Brachiopoda*).—These curious bivalves are symmetrical in form, and nearly always have the dorsal valve smaller than the ventral, the latter being produced into a

beak, through which is an aperture for the passage of the pedicel, by which the shell is attached to foreign bodies in the sea.

The ancient Etruscan and Roman lamps have so much the general form of these shells as to have given rise to the name "lamp-shells," the beak with its pedicel corresponding to the spout of the lamp through the hole in which the wick passes. On the Coloured Plate (see Vol. x., p. 241, Fig. 11) we figure *Waldheimia* (*Terebratula*) *Australis,* an elegant form, named after the accomplished Russian naturalist, Fischer de Waldheim. The visitor to the shell-gallery of the British Museum may see in the Brachiopod case, a stone dredged up by Professor J. Beete Jukes, in Port Jackson Harbour, Sydney, New South Wales, to which more than thirty specimens of *Waldheimia* are attached.

The shell-valves of the *Terebratula* are articulated together by two curved teeth arising from the border of the ventral, or beaked valve, which fit into two sockets in the other.

So complete is this hinge that it cannot be separated without injury to the shell; nor can the valves of *Waldheimia* be opened more than one-eighth of an inch without applying force.

If we rupture the hinge of any recent specimen we shall see that the muscles and digestive organs of *Terebratula* occupy an extremely small space near the beak of the shell, and are partitioned off by a membrane from the general cavity, which is occupied by the fringed arms that give rise to the name (*Brachiopoda*), it having been supposed that these organs corresponded with the foot of the *Gasteropod.* But it seems more correct to consider the pedicel as the true representative of the molluscan foot. These ciliated arms are variously modified in the different genera. They form two separate spiral coils in *Rhynchonella* and *Lingula,* but are united together by a membrane, and are only spiral at their tips, in *Terebratula* and *Discina.*

In *Waldheimia,* the smaller, or dorsal valve, which is fitted with the hinge-sockets, is also provided with a shelly loop in its interior, for the support of the fringed arms. These fringed arms correspond with the labial tentacles of the ordinary bivalves and the ciliary organs around the mouths of Polypes.

Few mollusks present points of greater interest than do the *Brachiopoda.* They all inhabit the sea; the fully developed shell being always found attached to rocks, or stones, branches of coral, or to other shells. The young (although their development has not as yet been recorded) are doubtless unattached, and able to swim freely, like the fry of

other bivalve mollusca, until they meet with suitable places for attachment.

They are found from low water to one hundred and twenty fathoms, and probably even deeper, and are distributed almost in every sea at the present day, whilst their range in geological time is only equalled by such forms as the microscopic *Foraminifera* and *Entomostraca;* species of fossil *Lingulæ* being met with in our oldest Cambrian and Silurian formations. At present only seventy living species have been met with, but as they are for the most part inhabitants of deep water, no doubt many more will be discovered, for good marine dredges are a comparatively modern invention, and deep-sea dredging is no easy task, as the writer can testify from personal experience on the coast of Spain.

More than one thousand extinct species of *Brachiopoda* have been described, representing, of course, a succession of geological periods, so that it is not improbable that they are nearly, if not quite, as numerous at the present day as formerly.

Some of the fossil species attained a very large size, and the palæozoic genera present remarkable variations in form from each other, and also from any now living. Dr. Gustaf Lindström has lately separated one group entirely, and placed them in a separate order, to be called, Operculated Radiata of the order *Rugosa.*

Floating Shells.—The *Pteropoda,** or "wing-shells," furnish good illustrations of this form of molluscan life (see Coloured Plate, Vol. x., p. 241, Fig. 1, *Cleodora pyramidata*). "This little group consists of animals whose entire life is passed in the open sea, far away from any shelter, save what is afforded by the floating Gulf Weed, and whose organization is specially adapted to that sphere of existence. In appearance and habits they strikingly resemble the fry of the ordinary sea-snails, swimming, like them, by the vigorous flapping of a pair of fins. To the naturalist ashore they are almost unknown, but the voyager on the great ocean meets with them where there is little else to arrest his attention, and marvels at their delicate forms and almost incredible numbers. They swarm in the tropics, and no less in Arctic seas, where by their myriads the water is discoloured for leagues (*Scoresby*). They are seen swimming on the surface in the heat of the day, as well as in the cool of the evening. Some of the larger kinds have prehensile tentacles, and their mouths armed with lingual teeth; so that, fragile as they are, they probably feed upon still smaller and feebler creatures (*e.g., Entomostraca*). In high latitudes they are the principal food of the whale, and of many sea-birds. Their shells are rarely drifted on shore, but

* So called from πτερον, a wing, and πουσ, ποδοσ, a foot.

abound in the fine sediment brought up by the dredge from great depths. A few species occur in the Tertiary strata of England and the continent; in the older rocks they are unknown, unless some comparatively gigantic forms (*Conularia* and *Theca*) have been rightly referred to this order." (Woodward's *Manual of Mollusca*, p. 202.)

It has been stated that the specific gravity of floating shells is lower than that of any others, and such may be the case with "the Paper Nautilus," *Argonauta, Ianthina, Carinaria* (see Plate, p. 21, Fig. 3), and Pteropods (see Coloured Plate, Vol. x., p. 241, Fig. 1). But none of these will float in the water by themselves. *Ianthina* is rendered buoyant by the air-vesicles attached to its foot, and the others are sustained by incessant muscular exertion in swimming. The *Nautilus* and *Spirula* are in no degree indebted to their specific gravity, but solely to the air-chambers with which their shells are furnished. For the shell of the *Spirula* is wholly composed of *nacre,* and the pearly lining of the *Nautilus* constitutes the greater part of the thickness of the shell. *Nacre,* we have seen, is *Aragonite* in its physical character, and has a higher specific gravity than the ordinary shell. The internal pen of the Calamary (*Loligo vulgaris*) is composed entirely of *Conchioline,* and is consequently lighter than any floating shell; but it would sink, nevertheless, if deprived of the air it contains. The "cuttle-bone," or shell of the *Sepia,* swims, because it is full of air. The author has seen it floating in the middle of the Bay of Biscay, and hence, no doubt, that many such shells are wafted by "Remell's current" from the coast of Portugal, and stranded on our own south-west shores. Professor Forbes remarked that he had never dredged a cuttle-bone, but multitudes were found cast ashore on all the coasts of Asia Minor.

The *Spirula* has never been taken alive, and rarely with any portion of the animal attached to the shell; but it must be abundant in the tropical Atlantic, as well as in the Coral Sea. In Brazil and the West Indies most likely, is its home. Millions of the shells, floated across the Atlantic by the Gulf Stream, are strewn on the shores of the Canary Islands. They are less common at Madeira and along the Iberian coast, and very rare in Devon and Ireland.

The dead shells of *Nautilus* abound in the Coral Sea, and are cast ashore in such profusion that many tons weight are collected at New Caledonia and the Feejee Islands, and conveyed to Sydney, where they sell for three halfpence each; or to the Navigator and Friendly Islands, where, not living, they are worth one shilling a piece. The young shells, of which ornaments are made, when polished, fetch a high price.

It seems superfluous to endeavour to explain the "floating"

of the *Nautilus*, since we have no positive assurance that it does ever visit the surface except when driven up by storms. From its form it is most likely an indifferent swimmer; no doubt it can swim backwards, like its relatives. The shell, when placed in a bucket of water, turns over and floats with its mouth downwards; if, however, a half ounce weight is placed in the opening, its centre of gravity is altered, and it then floats with the spire turned more to the surface, so that the weight is sustained in the shell without falling out.

It has generally been taken for granted that the Pearly Nautilus could rise and sink at will, and, as most authors have attributed the fabulous properties of the Argonaut to its Oriental relative, we might be misunderstood if we passed it over in silence. All writers before Buckland, and some at the present day, have explained the hydrodynamic parts by attributing a second, no less fabulous power, namely, of pumping out the water from its chambers in order to rise, and admitting it again when it wished to sink. Nor was the difficulty of explaining this feat the principal cause of its rejection. But the author of the *Geological Bridgewater Treatise* knew that in the beautiful *Nautilus zic-zac* of the Tertiaries, the siphuncle consisted of a succession of shelly funnels, fitting continuously, into one another, and totally excluding all communication with the chambers, which were closed cells, forming a permanent float. The Doctor was thus compelled to limit his hydrostatic theory to the siphuncle itself, a most inadequate apparatus! But the specific gravity of a body is not altered by altering its form; and, if no other means exist, the *Nautilus* must still depend on *swimming* to sustain itself in the water.

The patentees of the *Nautilus machine,* have hit upon a real method of varying the specific gravity of a submerged body, which may some day come into use (whether the *Nautilus* employed it or no).

Teleology of Form.—The first explanation which presents itself to our mind, in accounting for the variety in the form and construction of shells, is the universal law that "nature never repeats," and that, when things are different, the difference extends to every part of their organization.

In the structure of shells there is a general *adaptation to the wants of the animal* to which they belong. Thus we see *light shells* for the floaters and swimmers, *strength* for the Limpet and Periwinkle, *space* in the Cone and Nerite, *concealment* in *Phorus,* and roughness of surface in many others, which invite parasitic growth, or colours assimilated to the surface of attachment which the sedentary and fixed forms affect.

In considering the *Origin of variations in the form of shells,*

we should need a much more extensive and intimate knowledge of those which preceded the present races, in order to show that their relationship was that of descent. All we can now say is, that the present races closely resemble their immediate predecessors, and are more and more unlike the shells of older geological times. One fact is very apparent, that a great many have become extinct because they could not change and adapt themselves to new external conditions. Many have also become extinct in the regions where they once abounded, but still linger, in diminished numbers, in out-of-the-way localities, where the hostile influences were less severe.

MRS. CAMERON'S PHOTOGRAPHS.

In a former number we made some remarks on *Photography as a Fine Art,* and spoke of the success which had attended Mrs. Cameron's efforts to produce works more in accordance with the productions of great painters, than had hitherto been done by mechanical and chemical means. Since then we have examined a great many of this lady's photographs, and the high opinion we formed of them, not only on account of their individual merit, but also as tending to found a distinct school of photography, characterized by very remarkable qualities,—artistic and manipulative, have been confirmed. Like all innovators, Mrs. Cameron has had, and we might say has still, much prejudice to overcome; but if our readers will pay a visit to her portfolios, which may be seen at the well-known establishment of Messrs. Colnaghi, we are quite sure that those who possess the greatest knowledge of pictorial art, and the finest perceptions of beauty, will be the warmest in their admiration, and the loudest in their praise. Finely executed works by photographers of established reputation, no doubt exhibit qualities of a very meritorious kind, but it is very rarely that they produce anything like the feelings and sensations which arise in our minds, on contemplating pictures of, or fine engravings after, such artists as Correggio, Van Dyck, or Sir Joshua Reynolds. We accept the human face done into photography, as a species of translation into a language, imperfectly capable of expressing the required ideas, and rendering them, so far as it can do so, rather by an artificial and non-natural idiom, than by a simple and satisfactory phrase. Many things that add a charm to the countenance, such as the very delicate gradations of light and shade, which

give the sense of roundness, softness, and smoothness to the cheek, the transparent shadowiness lurking amongst tresses of hair—the varying tones of flesh colour—the suggestions of life and movement, which delight us in real figures possessing the requisite beauty, and in suitable positions, and which meet us in the delineations of the great masters, are wanting in the ordinary photograph, and have been marvellously introduced by Mrs. Cameron, in her processes of photographic art.

The most remarkable instance of this artist's success, is to be found in the child's head, "Number 6 of the series of twelve life-sized heads" and called "Alice." It has all the properties of a fine sepia drawing by a great master. It is rich in gradations of tint. The hair flows freely in fine masses, as if the wind had caught it: stray locks have swept across the forehead, and their delicate shadows give an exquisite softness to the brow. Beautiful hair, left free, is one of the most poetic of nature's productions, and very subtle and sympathetic are the combinations of light and shade which it exhibits, and which defy the efforts of ordinary artists to reproduce. Few of the old painters did justice to hair. They usually painted it in forms too stiff, and the ordinary photography reduces it to wires, or threads. Alice's hair is a masterpiece of art, and Mrs. Cameron has made her photographic apparatus succeed in producing those delicate transparent shadows which sorely test the manipulative skill of the oil painter.

This head of "Alice" exemplifies other fine qualities usually absent from photography. A good photographer of the common sort seldom approaches a grand mode of treatment. If his lights and shadows are strong and in conspicuous masses, they are generally damaged in artistic effect by the violence of their contrasts. The depths are too black, and the lights too white, and there is a want of half-tones. Another common photographic defect is giving too much prominence to detail, as the early artists did, and as the modern Pre-Raphaelites continue to do. Mrs. Cameron has advanced photography beyond this stage. In "Alice," and in other productions, she has introduced breadth and generalization; her contrasts are strong, but not violent, and she has been singularly successful with half-tones. The qualities we have mentioned belong to what we may call the technical, or manipulative branch of art; and they are essentials to success; but something more is wanted: a true work of art is also a work of mind, and Mrs. Cameron has rescued photography from mere copying. In her life-sized heads, as well as in her composition pieces, she has evinced rare faculties of dealing with the emotions of her sitters. She does not take them anyhow, but draws them out, and induces in them such a condition of mind and feeling as

gives rise to a vivid and pictorial expression of feature. Her process is not a quick one, and she must have unusual tact and skill in keeping her subjects happy, and in the mood she wants. One cause of failure in the expression of ordinary photographic portraits no doubt arises from the uncomfortable situation in which the subjects find themselves. Who can look interesting or natural in a glass garret, bothered with directions to stare at a brass knob: told when to wink, and ordered to sit still. "Wet your lips, and wink your eyes," were the directions to a party of ladies at one establishment; and others may, for aught we know, have recourse to Dickens' "prunes, prisms, and papa," to get the mouth into the required state. Those portrait painters who have been most successful in giving life-like expression to their works, have possessed the art of influencing the mental condition, and drawing out their subjects; and those photographers who wish to rise above the mechanism of their profession, must cultivate it, and must arrange their studios so as to make comfort, and natural expression, possible in them.

No. 12 of Mrs. Cameron's "life-sized heads" is so far a misnomer as it is *enlargement* of life, admirably done. It represents a noble-looking boy, a sort of young Jupiter, but with a touch of Mercury's mischief and fun. We have noticed that the size of this head puzzles many ordinary people, who would have admired it on a smaller scale, and it wants some little artistic education to appreciate any figures verging on the colossal. Placed at a suitable distance it is singularly effective, and artists view it with delight. In this piece Mrs. Cameron has thrown aside all tame conventionalism. The vigorous, free, natural treatment of the subject is worthy of a great sculptor, and if we regard "Alice" as the most pictorial of her portraits, this may be called the most statuesque.

We have not seen the original children of these portraits, and therefore can offer no opinion of how far Mrs. Cameron's process realizes a likeness, but we should imagine, from the vivacity and depth of expression, her success in this particular must be great. What is, however, most remarkable is, the extent to which she has made her portraits works of art. No one unconnected with the family would care to have photographs of Miss Brown or Master Jones, as such things are ordinarily done, even if the children were above the average in good looks, but a child painted by Correggio or Guercino is another thing. We do not ask the name of the model, but we prize the picture for qualities higher than those of mere resemblance to a particular person. Mrs. Cameron's "Alice" and the Jupiter-like boy belong to this rare and high class of

portrait which every one of artistic perception is so glad to possess.

Those of our readers who live in, or visit London will, no doubt, go to Colnaghi's, and look through the large collection of Mrs. Cameron's works, which are on sale at very moderate prices, and we recommend them to pay particular attention to her dramatic and composition pieces. Some effective theatrical pieces, with portraits of popular actors, have often been taken by the ordinary photographers, but Mrs. Cameron has set to work in a different way, and has made her pictures by getting her friends or acquaintances to form *tableaux vivants*, and then photographing them with her peculiar skill. We can only allude to this important branch of her new art, one of the finest specimens of which is a "Prospero and Miranda," marked "from life." This piece will be a great favourite as it becomes known, because it tells its tale so forcibly, and is remarkably pleasing in its character. A fine old Prospero, with vigorous features, long white beard, and intellectually-developed forehead, recounts to an intensely-listening, earnest-looking Miranda the story of her birth, and his expulsion from his dukedom. At the moment of the picture, Prospero is standing up, and Miranda, leaning forward, clasps one of his hands as if to give assurance that her soul was in his tale. The light glances down Prospero's forehead with its strong lines of thought, on Miranda's face, and on a portion of her simple dress. The background is very dark, and while Miranda's figure is distinct, Prospero's is only indicated—not shown. We have very few artists who could paint half so fine a picture of the scene as Mrs. Cameron has given us in this piece. We could fancy she had fished up a leaf of Prospero's "drowned" book, and rescued his staff from its burial-place "certain fathoms in the earth," when we notice the skill with which in this case, and in "Queen Esther," and several others we might name, she has composed her living pictures, and made her apparatus give them a permanent form.

It will soon become the fashion to admire these productions. Their novel merit now charms the few who know how to think for themselves on matters of art, and the many will bring their later, but useful homage, when fashionable authorities have told them it is the correct thing to do. Mrs. Cameron has only to persevere, and she will found a school of "Cameronians," though not after the fashion of the grim sect so named. Her productions are eminently genial, and from this quality and from their beauty they will find their appropriate resting-places in cultivated homes.

THE COAL MINES OF THE UNITED STATES OF NORTH AMERICA.*

BY F. M. LUBBREN.

In the United States coal is abundant, and can never be exhausted. Between the western extremity of the Appalachian coal-fields and Cincinnati, the different formations, from the Devonian to the Lower Silurian, come up to the surface in succession. At Portsmouth, next the lower coal measures, comes the inferior, or conglomerate grit, or millstone; next it, the Waverly sandstone, the equivalent of the Devonian. Then succeed the Upper Silurian slates and limestones, and lastly, at Cincinnati, the lower Silurian groups appear in the hills and beds of the Ohio.

There is one vast coal-field extending from New York to Alabama, which covers nearly one hundred thousand square miles. Another coal-field in Indiana embraces about fifty-five thousand square miles. Another in Michigan covers about twelve thousand square miles. The grand total amounts to two hundred and twenty-five thousand square miles, and the whole amount of coal, estimating the average thickness of the beds to be fifty feet, would be three millions and a half of cubic miles, a quantity absolutely inconceivable.

Before the late civil war, the average price of coal in Pennsylvania was five dollars per ton, and in New York not far from six dollars per ton.† The relative cost of transportation to New York and to London from the mines was then about the same.

The principal portion of the coal used in the United States for domestic purposes is brought from Pennsylvania. This coal is anthracite, or hard, and the only large deposits of this species of coal of a good quality in the United States, so far as is known, are found in that region. Anthracite coal exists in Rhode Island and Massachusetts, but it is much less combustible than in Pennsylvania.

The remainder of the vast coal-fields which we have enumerated comprise coal which is more or less *bituminous*, and is more commonly used in this country for generating steam than for domestic purposes. It is similar, however, to the English

* *State Survey of Pennsylvania.* By Professor H. D. Rogers.
Statistical Report on the Iron and Coal of Pennsylvania. Prepared by Dr. Charles M. Wetherell, and published in a work entitled *Science and Mechanism*, 1853-4.
State Survey of New York. By Mr. Hall. Albany, 1843.
State Survey of Virginia. By Professor W. B. Rodgers.

† Since the civil war the price of coal is more than double.

coal, and could be as readily burned in grates. The coal formations of this country, although the mineral differs in character, are of the same geological era. The difference in the amount of bitumen is caused by the greater disturbance to which some portions of the coal-fields have been subjected.

The hard coal is found on the slopes of the Alleghanies, where, by the upheaval of heated mineral masses, the bitumen has been expelled, and the coal converted into anthracite. The bitumen in coal increases as the beds pass westward towards the Mississippi, where, as well as on the Pacific shores, the quantity of bitumen is equal to that in English sea-coal.

There are three great anthracite coal-fields in Pennsylvania, namely, the Southern, Middle, and Northern.

I. The southern coal-field is divided into four mining districts, the Lehigh, the Schuylkill, the Swatara, and the Susquehannah.

II. The middle coal-field is north of the southern, having the Beaver meadow mines in the eastern extremity, and the Shamokin and Mahony mines on the Susquehannah.

The Shamokin mines, are worked horizontally by digging into the mountain. This coal is called the "Peacock," on account of the brilliant golden purple and green tints it presents to the eye, but it is not as durable as the coal from the Pottsville and other mines, burning either to a white or red ash. It ignites easily, and burns very brightly.

III. The northern coal-field lies twenty-five to thirty miles east of the Middle Basin, including the Wyoming and Lackawanna valleys, and finds its market in New York.

The following remarks will be confined to a brief notice of the southern coal-field.

Canals and railroads have been constructed here with a boldness of design and magnificence of enterprise that will compare with any works of the kind in this or the old world.

This field is sixty-five miles in length, and averaging about four miles in width, and enclosed or bounded by a continuous mountain, which separates it by about ten miles from the second coal-field, forming a longitudinal basin. This boundary is called Broad Mountain on the north, and Sharp Mountain on the south, and is penetrated by the rivers Schuylkill and Swatara, which afford the inlets for the necessary canals and railroads.

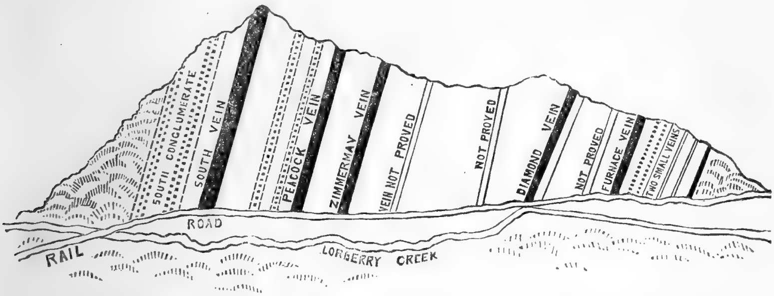
1. The nearest anthracite coal-field to tide-water is on the Lehigh river. The Lehigh river, however, unlike the Schuylkill and Swatara, does not penetrate the coal-field, and hence the coal-mines could only be reached by ascending and descending, through inclined plains and railways, Sharp

Mountain at its greatest elevation. From the basin, when thus reached, the coal is transported by stationary power a distance of nine miles to the navigation at Mauch-Chunk. There is nothing in the States that surpasses the enterprise here exhibited, to overcome the obstacles presented by the surface of the country between these mines and the river Lehigh, and nothing would have justified the outlay but coal mines. The mines in this district are worked like an open quarry on the slope of a mountain, and the coal is conveyed as stated by a self-acting railroad down a declivity from 100 to 140 feet per mile to the canal. This navigation was completed in 1820, and 3657 tons delivered that year in Philadelphia, and in 1847 the quantity increased to 643,272 tons, and the trade has been increasing at a ratio, per annum, of twenty per cent. The capacity of this navigation by the Delaware division of the Pennsylvania canal and the Morris canal has been considered fully equal to the transport of a million and a half tons of coals.

2. The Schuylkill district is the centre of the basin, and is very extensive, embracing more than one-half of the entire field, viz., the mines of Tamaqua (which adjoin the Lehigh mines), Tuscarora, Port Carbon, Pottsville, Minersville, and Tremont. In this anthracite coal-field of Schuylkill county, whose outlets are at Mount Carbon, Port Carbon, Schuylkill Haven, and Port Clinton are one hundred and eleven collieries, of which fifty-eight are red ash coal and fifty-three white ash; sixty-two of these collieries are working coal out above water-level, and forty-nine below water-level. There was shipped from this region a total of 2,450,950 tons in the year 1852. The thickest vein worked is thirty feet, and the smallest two feet.

3. The Swatara district commands a rich and most valuable portion of the coal-field, and is mined through the channels of the Union Canal Company, and Susquehannah and Tidewater Canal. It averages about eighteen miles long by six broad, containing 69,120 acres of coal-land. In this mining district are seven hills from 300 to 800 feet in height, running parallel, or nearly so, separated by narrow valleys, which in some places, remote from the streams, are nearly level with the mountain ridges, but which near the gaps are worn down by the water-courses which drain the coal-basin. In these high ridges are deposited the veins of coal; they are called the Sharp Mountain, the Red Mountain, the Coal Mountain, the Little Lick, the Big Lick Mountains, the Thick Mountain, and the Broad Mountain. The Swatara river or its branches are broken through all these ridges, except the Broad Mountain, at which it penetrates. The coal of the Sharp Mountain is of the red ash variety. It is a free burning coal, ignites

easily, leaves but little residuum, burns with a bright yellow blaze, without smell or smoke, and is an excellent article for blacksmithing, as well as for parlour purposes. The expenditure in this region up to 1847 has not been great. In that year 61,000 tons were exported.



SHARP MOUNTAIN OF THE SWATARA MINING DISTRICT, PENNSYLVANIA.

Scale 400 Feet to the Inch.

South Conglomerate, about 120 feet thick.
South Vein, 5 feet thick.
Peacock Vein, 8 ,,
Zimmerman Vein, 4 ,,
Diamond Vein, 3 feet thick.
Furnace Vein, 6 ,,
From South Conglomerate to Furnace Vein, 1680 feet.

The Sharp Mountain lies next to the southern boundary of the coal-field. Its length in the Swatara Mining District is more than twenty miles, rising in some places 800 feet from its southern base. On the west side of Lorberry Creek Gap, the pinnacle called the Panther's Head is 725 feet higher than the railroad. The Great Conglomerate is at the southern base of the mountain. Here are no "horizontal heaves," or derangement of the coal-measures, as is the case in the Schuylkill district. The veins at Lorberry Creek run directly across the creek, from the mountain on one side to the mountain on the other. Their course on both sides of the gap, is north 68° east. Those in the southern half of the mountain having a south dip of about 74°, and those in the northern half about 67°.

The *Conglomerate,* which forms the general base of the coal-measures, is 1500 feet thick in the Sharp Mountain near Pottsville; whereas it has only a thickness of 500 feet about thirty miles to the north-west, and dwindles gradually away to thirty feet. The *Limestones,* on the other hand, of the coal measures, augment as we trace them westward. Similar observations have been made in regard to the *Silurian* and *Devonian* formations in New York; the sandstones and all the mechanically-formed rocks thinning out as they go westward,

and the limestones thickening as it were at their expense. It is therefore clear that the ancient land was to the east; the deep sea with its banks of corals and shells to the west; and from the identity of fossil plants and the relative position of the anthracite, it must be of the same age as the bituminous. We find the coal most bituminous where it remains level and unbroken, and that it becomes progressively debituminized towards the more bent and distorted rocks.

The diagram exhibits the veins of coal by a geological section across the Sharp Mountain at Lorberry Creek. It is an end vein of the Panther's Head on the west side of the gap.

For further particulars consult *A Report to the Legislature of Pennsylvania,* containing a description of the Swatara Mining District, illustrated by Diagrams, with a very large map. 61 pp., Harrisburg, 1839.

4. The Susquehannah district embraces the western terminus of the southern coal-field, branching out into two divisions towards the Susquehannah—the southern, or Stony Creek coal region, and the Lyken's Valley. The basin is thirty-two miles long by four and a half in breadth. The primitive position of the vein of coal of this region is generally unchanged, as a consequence rendering their investigation and development much more easy, and less liable to the occurrence of those "faults" and "breaks" which have proved so disastrous to capital and discouraging to labour in other regions. The thickness of the beds of coal in this region is estimated at twenty-nine feet, yielding at least 60,000 tons to the acre. Over half a million tons of coal are sent annually hence to market.

The coal-lands are generally owned by corporations or wealthy individuals, and are leased to operators, who pay a certain fixed sum for every ton mined. The coal is consigned to commission-merchants, by whom it is sold by the cargo, generally upon contracts made early in the season.

The coal is procured by driving drifts into the mountain ends, or by sinking sloping shafts and putting engines upon the veins. When the first level of a slope is sunk down, the coal is mined with comparative facility and little expense. This level will last from four to six years if the veins and the run upon it be fair, but at the end of that time a new level must be sunk, and the slope must be doubled in depth; in fact, a new mine must be created 350 feet below the surface, and when "faults" are met, bankruptcy often ensues. Indeed, few have ever successfully overcome the third level of a slope.

From statistics of coal mined in the United States during

the year 1860, ending on June 1st, it appears that the total amount of anthracite coal mined was 9,398,332 tons. Of this, 1000 tons came from Rhode Island, and all the rest from Pennsylvania. The amount of bituminous coal mined in the same year was 5,842,559 tons. Of this, Pennsylvania supplied about 2,700,000 tons. The anthracite coal was valued at 11,874,574 dollars, and the bituminous at 7,526,681 dollars, making a total of 19,401,255 dollars.

ADDENDA.

On the roofs of the coal seams are shales with distinct impressions of ferns, as the *Pecopteris lonchitica,* the *Neuropteris cordata,* and stems and trunks are found of the *Lepidodendron, Calamites, Sigillaria* and *Stigmaria,* of which latter there is an abundance in the mines at Blossberg, Pennsylvania, often several yards long with their leaves and rootlets attached.

Statistics of Coal Mines in the United States in the Year ending June 1st, 1860.

The following statistics of the coal mined in the United States during the year 1860 appeared in the report of the last census :—

	Bituminous.		Anthracite.	
States.	Bushels.	Value.	Tons.	Value.
Rhode Island	95,000	$28,500	1,000	$5,000
Pennsylvania	66,994,295	2,833,959	9,397,332	11,719,574
Maryland	11,200,000	461,338		
Ohio	28,339,910	1,539,713		
Indiana	379,035	27,000		
Illinois	14,258,120	964,187		
Iowa	72,500	6,500		
Missouri	97,000	8,200		
Tennessee	3,474,100	413,662		
Kentucky	6,732,100	476,800		
Virginia	11,229,675	725,678		
Alabama	10,000	1,200		
Georgia	48,000	4,800		
Washington Territory	134,350	32,244		
Bushels	146,063,975	$7,526,681		

Twenty-five bushels to a ton is 5,842,559 tons.

Anthracite tons	9,398,332	$11,874,574
Bituminous tons	5,842,559	7,526,681
		$19,401,255
Value of coal mined in 1850, agreeably to census returns		$7,173,750
Increase (171 per cent.)		$12,227,505

ON TELEGRAPHIC COMMUNICATION BY MEANS OF A NUMERICAL CODE.

BY LIEUT. J. HERSCHEL, R.E.

THE object of telegraphy is the transmission of a series of WORDS, *signs*, or *symbols*, representing ideas; and this object will be best attained when those words, signs, and symbols are transmitted with the least possible expenditure of labour and time, consistently with a minimum risk of error. To arrive at a just conclusion as to the means to this end, it is necessary to consider the nature of these words, signs, and symbols, and, possibly, of the ideas which they represent.

The *signs* and *symbols* which it is required to transmit are few in number as compared with the words: the letters of the alphabet, the ten numerals (not necessary since they have *names*, or may be represented by words), and a very limited number of symbols, such as punctuation signs, algebraical signs, etc. (which may for the most part, if not entirely, be known, like the numerals, by their *names*, or the words representing them); these include all that, in practice, it is desirable to transmit of this class.

The principal medium of communication of ideas is *words*. All words are susceptible of scription in letters, and existing telegraphy does transmit them by means of the letters which compose them, or at any rate by the transmission of the more important letters which form the words. By a "word," I understand any combination of letters which has an accepted signification, whatever place that combination or word may have in syntax or grammar, or whatever its signification may be. Existing telegraphy therefore may be understood to communicate ideas by the transmission of a series of combinations, simple or complex, of a limited number of symbols and letters. Assuming that telegraphy can, in practice, only transmit simple signals, out of which can be formed a variety of combinations, it is clear that the simplicity of communication must depend on that of the combinations necessary to represent the words, etc., communicated. Now the primitive signals are but two in number, by the repetition and arrangement of which letters, symbols, and numerals are represented. These latter may be called the telegraphic alphabet; and it is evident that the more extended this alphabet, the greater the variety of the arrangement of the primitive signals must be. According to the existing system this alphabet contains at least *forty* individuals. It is the object of these remarks to show that *ten* will suffice; and even should it appear that the actual

number of "telegraphic letters" transmitted for a given message, would be greater with such a curtailed alphabet, than would be the case with the existing one, it is contended that the immediate gain from this reduction would outweigh the disadvantage which a more copious alphabet labours under, of requiring a more elaborate arrangement and a greater number of repetitions of the primitive signals. But in point of fact the actual number of telegraphic letters transmitted would also be less. For words are *special* combinations, and since a vast number of possible combinations are excluded, which do not form words, the existing combinations which do form words must contain a much larger number of components than would be the case were every available combination occupied by a recognized word. We shall not be far wrong if we assign five as the average number of letters in an English word. Perhaps the true average is a fraction less than five, but if we take into account the habitual omission in telegraphy of unimportant words (which are always short), the estimate will stand good. Now the number of possible combinations of ten symbols, five or less in each, is 100,000. This is clearly greater than the actual number of recognized words in the English (or any) language which has the command of twenty-six symbols, and is not restricted even to twelve or fifteen of them in the formation of any word. Not only then may every useful word of the English language, and of the French too, be represented by a different combination of five symbols out of ten, but a large margin will remain available for almost any conceivably useful variety of signs or phrases. They will not require the transmission, on the whole, of a greater number of symbols or "telegraphic letters" than are now transmitted; but, on the other hand, will require a very much smaller number of "primitive signs" or impulses.

What, now, are the disadvantages of such a system of signals? The principal one is the necessity of a dictionary. A telegraphic dictionary would have to be compiled, and invariably used at both ends of the wire (but not necessarily at intermediate repetition stations). A vast amount of care, and knowledge, and foresight might be spent with advantage in the compilation of this dictionary, whereby the saving of signals would be immense, as for instance, all words of three letters (or less), besides a great number of the more common words of more letters, might be assigned numbers between ten and 1000, whereby the bulk of messages would be susceptible of transmission by combinations of three symbols only—by "telegraphic three-lettered words" so to speak. Nearly, if not actually, the whole of the remaining words of the language might be assigned numbers from 1000 to 10,000,

and might thus be transmitted by "telegraphic four-lettered words."

As Arabic numbers are universally recognized in Europe, such a system would obviate the principal inconvenience of foreign telegraphy; for each nation and language might have its own dictionary; and since there would be less risk of error in the actual transmission and receipt of a message by the telegraph officials when once it was converted into telegraphic language, so also would there be greater control over the conversion and reconversion, in the hands of the sender and receiver.

Since there is no reason why certain numbers—say those from ten to thirty-six—should not be assigned to the letters of the alphabet, the proposed system does not forbid or interfere with the use of cipher, or with the transmission of words or names omitted in the dictionary, or newly coined, or wrongly spelt, or otherwise unrepresented.

The scheme is a perfectly *feasible* one. An ordinary octavo page of the dictionary might contain 200 words, so that 5 to 10 pages would contain the bulk of common short words, 50 to 100 would contain nearly the whole language; while an ordinary octavo volume of 500 pages would contain all that the ingenuity of the compiler could find to put into it.

No attempt is here made at a complete enumeration of all the advantages which such a codification would possess, nor indeed to enter fully into the many bearings of the question. It is sufficient for my present purpose to point out the enormous advantage of signalling by *numbers* instead of by *letters*.

I append rough data for comparison with the estimates I have made above of the use of words and letters.

"A well educated man in England, who has been at a public school and at the university, who reads his Bible, his Shakespeare, the *Times*, and all the books in Mudie's library, seldom uses more than 3,000 or 4,000 words* in actual conversation. Actual thinkers and close reasoners, who avoid vague and general expressions, and wait till they find a word that exactly fits their meaning, employ a larger stock, and eloquent speakers may rise to the command of 10,000."—*Max Müller's Lectures*, p. 254.

"Shakespeare," he says, "uses about 15,000 (a greater

* It is not quite clear from the context what is to be understood by the term "word" as here used. It probably excludes inflectional forms. If so, then, considering that most substantives have one, most verbs three, inflections, it will be necessary to double the estimates here made, to accord with my use of the term. But this will not affect the broad question of the advantages of codification materially.

number than any other writer), Milton about 8,000; while the Old Testament contains but 5,642 words."

In the *Times* of the 12th November, 1866, the usual telegram column furnishes the following estimate of the number of letters per word:—

Words of	1	letter	1	giving	1	letter
,,	2	letters	37	,,	74	letters
,,	3	,,	48	,,	144	,,
,,	4	,,	30	,,	120	,,
,,	5	,,	9*	,,	45	,,
,,	6	,,	23	,,	138	,,
,,	7	,,	14	,,	98	,,
,,	8	,,	17	,,	136	,,
,,	9	or more	21	,, say	210	,,
Total			200	words containing	966	letters
				Average	4·8	,,

* The paucity of five lettered words is not unworthy of note. It possibly is due to the step from monosyllabic to bisyllabic utterance.

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

BY G. M. WHIPPLE.

1866.	Reduced to mean of day.					Temperature of Air.			At 9·30 A.M., 2·30 P.M., and 5 P.M., respectively.		
			Calculated.								
Day of Month.	Barometer, corrected to Temp. 32°.*	Temperature of Air.	Dew Point.	Relative Humidity.	Tension of Vapour.	Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9·30 A.M.	Daily Range.	Proportion of Sky clouded.	Direction of Wind.	Rain—read at 9·30 A.M.
	inches.	°	°		inch.	°	°	°	0—10		inches.
Oct. 1	30·062	55·0	53·5	·95	·442	60·2	53·1	7·1	8, 10, 9	NE, NE, N.	0·000
,, 2	29·988	57·0	56·0	·97	·473	61·7	52·8	8·9	10, 10, 8	NNE, ENE, NNW.	·000
,, 3	30·051	60·8	56·9	·87	·537	66·7	55·2	11·5	2, 10, 3	—, NNE, N by W.	·000
,, 4	30·089	56·3	56·2	·99	·462	60·8	55·1	5·7	10, 10, 10	NNW, N by W, N.	·000
,, 5	30·288	53·5	51·1	·92	·420	57·0	53·3	3·7	10, 10, 10	NNW, N by E, NNE.	·000
,, 6	30·452	55·5	53·8	·94	·450	59·8	53·5	6·3	10, 10, 10	NE by N, N, NNW.	·000
,, 7	...	...	...	...	...	61·7	55·2	6·5	...	... ...	·000
,, 8	30·341	56·6	50·4	·81	·467	64·1	46·7	17·4	9, 0, 1	NE by N, E, ENE.	·000
,, 9	30·190	53·3	47·0	·81	·417	59·3	51·7	7·6	9, 8, 8	E by N, ENE, ENE.	·000
,, 10	30·035	53·3	45·6	·77	·417	58·4	50·5	7·9	9, 7, 9	E, E, E by N.	·000
,, 11	30·030	52·5	45·8	·79	·406	56·3	48·7	7·6	9, 10, 8	ENE, NE by E, ENE.	·000
,, 12	29·985	51·6	47·6	·87	·394	57·6	45·8	11·8	9, 9, 3	NE, E, E.	·000
,, 13	29·915	47·0	42·3	·85	·337	55·9	35·8	20·1	10, 1, 9	—, S, SSW.	·000
,, 14	...	...	...	...	...	54·2	40·3	13·9	...	... ...	·037
,, 15	30·153	47·1	38·5	·74	·338	53·3	35·2	18·1	4, 3, 10	SW by S, W by N, NW by W.	·003
,, 16	30·197	42·6	38·0	·85	·289	51·6	31·0	20·6	0, 7, 0	—, NE, NE.	·000
,, 17	30·018	49·6	39·7	·71	·368	55·1	38·7	16·4	0, 8, 3	ESE, E by S, E by S.	·000
,, 18	29·864	49·2	50·1	1·00	·363	53·1	44·6	8·5	10, 10, 10	E by S, E, E.	·177
,, 19	30·043	58·1	56·7	·95	·491	64·5	48·6	15·9	10, 8, 7	S, S, S by E.	·573
,, 20	30·172	56·4	56·3	·99	·463	61·0	52·6	8·4	9, 10, 10	E by N, E by N, E.	·010
,, 21	...	...	...	...	...	62·1	51·7	10·4	...	... ...	·032
,, 22	29·918	53·6	53·2	·98	·422	62·2	51·3	10·9	10, 10, 10	ENE, W, W by N.	·010
,, 23	30·129	52·4	51·4	·96	·405	57·8	38·6	9·2	9, 10, 10	SW, SW, SW by W.	·280
,, 24	29·857	52·0	47·2	·85	·400	58·5	47·0	11·5	5, 7, 6	S, SW, S.	·000
,, 25	29·666	42·9	41·0	·93	·292	49·1	44·1	5·0	10, 10, 10	N by W, NW by W, N.	·320
,, 26	29·930	47·2	42·7	·86	·339	52·1	43·8	8·3	7, 2, 7	N by W, NNE, NW by N.	·084
,, 27	30·008	43·5	41·5	·93	·298	51·3	31·1	20·2	10, 4, 10	—, SSW, S.	·000
,, 28	...	...	...	...	...	54·0	37·2	16·8	...	... ...	·057
,, 29	30·354	44·4	40·3	·87	·308	52·7	32·7	20·0	1, 10, 10	WSW, S by W, SW.	·000
,, 30	29·815	52·5	49·9	·91	·406	56·8	40·9	15·9	10, 10, 9	SW by S, WSW, W.	·010
,, 31	30·098	45·2	40·0	·84	·316	52·5	36·8	15·7	0, 1, 1	WSW, W, WSW.	·040
Daily Means.	30·061	51·4	47·9	·88	·397	...	...	11·8	...	... ...	1·633

* To obtain the Barometric pressure at the sea-level these numbers must be increased by ·037 inch.

HOURLY MOVEMENT OF THE WIND (IN MILES), AS RECORDED BY ROBINSON'S ANEMOMETER.—OCTOBER, 1866.

Day.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Hourly Means.
Hour.																																
12	10	7	3	6	6	10	5	8	9	7	12	5	1	3	5	1	9	11		9				4	13	9	1	5	4	16	7	6·9
A. M. 1	13	6	4	9	6	5	5	8	9	8	12	2	1	4	6	1	6	11		9				2	6	11	1	3	4	14	6	6·4
2	8	7	1	6	9	3	5	8	7	9	12	2	3	3	5	1	6	12		10				4	5	10	2	5	4	17	6	6·3
3	9	6	1	11	9	4	4	8	8	7	13	4	4	3	4	2	8	13		11				3	2	10	1	7	4	16	6	6·6
4	10	8	2	5	9	6	4	9	10	12	13	3	3	4	2	2	7	12		9				5	3	11	1	6	5	17	4	6·6
5	10	7	1	10	8	7	4	10	12	11	11	1	2	2	2	2	9	8		6				5	3	10	2	5	4	19	4	6·5
6	13	6	2	6	6	7	5	8	13	12	11	2	1	4	3	1	8	10		6				5	3	9	2	8	5	19	3	6·6
7	15	8	3	5	8	9	7	11	13	11	11	1	3	2	1	2	9	9		5				7	4	10	1	7	5	18	4	7·0
8	13	9	4	5	7	10	8	10	12	15	12	4	3	2	1	1	13	11		6				10	7	8	2	15	5	25	4	8·2
9	11	8	2	5	8	12	7	10	13	15	14	4	3	2	5	1	13	11		5				11	4	10	2	16	6	25	4	8·4
10	10	8	1	6	9	8	11	14	17	12	12	6	4	3	5	3	24		13					12	5	12	2	18	6	24	4	9·6
11	11	9	4	6	8	9	12	13	17	15	13	7	3	5	5	4	24		13		195	138	127	16	6	11	7	20	11	29	3	10·8
12	13	7	3	6	9	10	13	15	16	19	18	9	3	9	4	6	21		11					19	7	13	3	20	12	24	6	11·4
P. M. 1	10	8	3	5	8	7	11	16	15	17	15	7	3	9	6	5	21		13					18	8	11	3	23	10	20	7	10·7
2	9	5	6	4	8	7	10	16	16	14	16	10	3	8	7	6	17		11					17	7	10	3	17	13	16	5	10·0
3	9	6	5	6	8	7	11	13	11	11	13	5	1	9	6	7	15		9				29	14	7	8	2	16	11	14	7	8·9
4	6	4	4	5	7	7	10	8	13	14	13	6	2	14	4	4	12		9					12	6	7	4	11	9	10	5	7·9
5	7	3	5	5	9	5	10	8	13	16	12	2	1	16	1	3	13		8				6	10	6	2	5	9	9	11	5	7·7
6	7	1	6	4	5	7	6	10	13	14	12	0	2	14	2	6	14		8				8	9	6	6	4	8	9	10	5	7·5
7	9	2	5	3	4	9	8	9	12	18	10	2	1	10	2	7	11		7				7	8	7	7	3	11	8	11	5	7·5
8	9	4	3	4	3	9	10	7	13	14	9	2	3	15	1	7	10		10				5	8	6	1	3	6	10	9	6	7·2
9	8	5	6	5	6	8	9	9	11	13	9	1	4	12	1	8	10	217	8				6	9	5	2	3	4	12	8	4	7·2
10	8	5	3	3	7	9	10	9	9	13	5	0	2	13	3	8	10		10				4	10	7	1	2	4	13	7	5	6·9
11	6	3	6	4	9	6	9	10	7	13	5	4	2	8	0	7	10		9				5	11	9	1	4	5	14	9	3	6·9
12																																
Total Daily Movement.	234	142	83	134	176	181	194	247	289	310	283	89	58	174	81	95	300	464						229	142	190	63	249	193	388	118	7·7

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

1866. Day of Month.	Reduced to mean of day. Barometer corrected to Temp. 32°.*	Temperature of Air.	Calculated. Dew Point.	Relative Humidity.	Tension of Vapour.	Temperature of Air. Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9·30 A.M.	Daily Range.	At 9·30 A.M., 2·30 P.M., and 5 P.M. respectively. Proportion of Sky clouded.	Direction of Wind.	Rain—read at 9·30 A.M.
	inches.	°	°		inch.	°	°	°	0—10		inches.
Nov. 1	29·945	51·7	47·5	·87	·395	55·0	39·7	15·3	10, 10, 10	W by S, W by S, S.	0·000
" 2	29·790	54·4	52·0	·92	·433	59·5	47·6	11·9	10, 9, 10	S by W, SW, SSW.	·023
" 3	29·636	52·2	49·3	·90	·402	57·6	50·5	7·1	10, 8, 8	SSW, SW, SW by S.	·012
" 4	...	...	...	...	...	54·5	37·4	17·1	...	... ...	·053
" 5	29·917	54·0	50·8	·90	·427	57·7	45·5	12·2	9, 10, 10	SW by S, WSW, WSW.	·005
" 6	30·075	52·4	47·2	·84	·405	57·2	50·5	6·7	0, 4, 8	WSW, W, W.	·000
" 7	30·051	52·6	47·5	·84	·408	55·5	43·7	11·8	10, 9, 10	W, SW by W, W by S.	·000
" 8	29·805	53·7	49·8	·88	·423	57·9	51·3	6·6	8, 10, 10	SW, SW by W, SW.	·010
" 9	29·890	44·1	36·4	·76	·305	—	38·0	—	0, 4, 0	N, W by N, WSW.	·315
" 10	30·120	34·0	34·2	1·00	·214	55·8	29·6	26·2	10, 10, —	—, —, —.	·000
" 11	...	...	...	...	...	56·6	31·7	24·9	...	... ...	·300
" 12	29·882	48·5	45·5	·90	·354	58·6	38·0	20·6	10, 10, 10	WSW, SW by S, S.	·000
" 13	29·625	52·0	45·4	·80	·399	56·9	47·3	9·6	10, 7, 2	W by S, W, W.	·134
" 14	29·982	44·5	34·0	·69	·309	49·7	41·5	8·2	0, 4, 4	W by N, W by N, W.	·040
" 15	30·019	44·5	39·4	·84	·309	47·7	33·4	14·3	9, 10 10	SW, S by W, SSW.	·000
" 16	29·288	51·9	45·9	·81	·398	56·6	42·7	13·9	10, 5, 4	SW by S, W by S, W.	·017
" 17	30·256	35·3	25·0	·69	·224	40·3	32·6	7·7	0, 1, 4	SW, NW by N, NW.	·010
" 18	...	...	...	...	...	52·7	31·3	21·4	...	... ...	·230
" 19	29·946	35·1	20·8	·60	·222	38·8	35·0	3·8	3, 0, 0	NW, NW, NW by W.	·090
" 20	30·185	32·8	24·7	·75	·205	37·9	29·0	8·9	0, 0, 0	NW by W, NW by W, W.	·000
" 21	30·101	38·6	34·6	·87	·251	44·6	25·9	18·7	7, 0, 7	WSW, WNW, SW by W.	·000
" 22	30·200	42·8	40·8	·93	·291	45·8	33·9	11·9	10, 10, 10	SW, W by S, WSW.	·000
" 23	29·777	46·0	43·2	·91	·325	49·6	41·1	8·5	10, 10, 10	SW, W by S, WSW.	·036
" 24	29·911	41·1	37·2	·87	·274	45·5	37·1	8·4	1, 10, 10	W, SW by W, SW by W.	—
" 25	...	...	...	...	...	48·1	39·2	8·9	...	... ...	·000
" 26	29·977	42·9	34·8	·75	·292	48·6	36·0	12·6	10, 2, 10	NW, NW, WSW.	·000
" 27	29·968	45·6	37·3	·75	·321	49·5	41·5	8·0	9, 8, 1	NW by W, NW, NW.	·000
" 28	30·266	38·3	35·1	·89	·249	45·5	30·4	15·1	0, 0, 0	SSW, W, W by S.	·000
" 29	30·259	40·9	36·1	·85	·273	46·9	29·8	17·1	7, 1, 10	—, S by E, E.	·000
" 30	30·054	35·3	27·7	·76	·224	40·1	30·6	9·5	0, 0, 0	E, E, E by N.	·000
Daily Means.	29·959	44·8	39·3	·83	·320	...	...	12·6	...	... ...	1·275

* To obtain the Barometric pressure at the sea-level these numbers must be increased by ·037 inch.

HOURLY MOVEMENT OF THE WIND (IN MILES), AS RECORDED BY ROBINSON'S ANEMOMETER.—Nov., 1866.

Day.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	Hourly Means.
Hour. A.M. 12–1	3	5	4	2	8	13	7	10	7	3	24	5	21	20	8	19	17	7	10	15	7	3	8	15	15	11	13	5	1	14	10·0
1–2	7	2	6	4	11	12	8	11	7	3	25	5	21	22	7	20	16	12	10	12	3	4	5	16	15	11	15	4	1	15	10·3
2–3	9	2	8	2	12	11	7	11	9	3	26	3	23	18	5	17	13	8	8	10	5	4	6	18	15	11	12	·5	1	20	10·0
3–4	8	3	10	3	14	11	12	11	7	1	27	5	22	19	6	19	12	10	8	11	5	6	7	15	15	13	11	4	3	15	10·4
4–5	6	2	10	3	15	11	11	13	9	2	20	5	21	19	6	20	10	17	14	9	7	4	7	13	16	12	14	4	2	7	10·3
5–6	11	1	7	6	14	12	9	15	10	1	15	5	22	19	6	20	12	16	12	8	6	4	6	8	13	7	10	4	1	3	9·4
6–7	8	5	10	6	13	10	13	15	10	1	17	5	23	20	7	22	9	17	11	8	6	1	7	9	12	8	18	4	2	9	10·2
7–8	8	6	11	7	13	10	13	16	10	2	18	7	24	21	7	21	11	20	12	9	7	4	11	9	15	12	18	4	2	11	11·3
8–9	8	6	14	5	15	9	18	17	11	2	21	4	26	24	6	22	10	19	15	5	7	6	13	6	13	15	15	4	1	13	11·7
9–10	8	5	14	7	18	8	17	24	15	1	18	6	17	25	8	22	10	18	13	5	7	5	12	8	11	15	14	4	1	15	11·7
10–11	12	11	17	11	20	16	19	24	18	1	15	7	10	23	10	22	10	20	16	9	10	7	15	12	17	19	17	5	0	12	13·5
11–12	13	14	20	11	21	16	24	26	20	2	14	10	12	24	14	21	11	17	17	9	12	5	30	10	20	20	19	5	2	14	15·1
P.M. 12–1	13	15	15	14	23	15	19	23	19	2	19	10	16	25	13	23	12	18	19	10	14	5	14	11	21	18	17	4	2	12	14·7
1–2	8	12	9	13	24	16	18	25	15	2	19	7	15	20	11	25	12	17	17	11	13	6	15	7	16	13	18	4	6	12	13·3
2–3	9	10	13	14	22	15	17	24	15	3	17	9	19	18	12	25	10	17	17	10	12	6	14	5	17	14	13	4	6	12	13·3
3–4	6	11	14	11	17	11	17	23	10	2	12	10	18	13	15	25	7	14	14	5	6	5	16	7	20	8	10	4	4	9	11·4
4–5	6	9	10	13	18	9	13	23	8	2	9	10	16	12	17	24	5	13	12	4	5	5	16	6	14	9	8	2	2	9	10·6
5–6	5	8	8	12	15	9	12	22	6	3	7	7	11	9	15	20	5	6	10	6	6	4	20	10	13	6	6	2	4	12	9·2
6–7	5	6	6	12	15	8	11	22	4	9	5	9	13	9	17	20	3	6	10	7	5	4	15	7	12	6	8	2	3	7	8·9
7–8	9	5	4	13	13	9	13	17	17	10	7	14	11	9	15	25	7	8	10	5	4	4	17	12	13	8	8	2	4	11	10·1
8–9	6	9	4	14	12	8	14	7	6	8	7	19	10	11	15	23	5	7	10	4	3	4	13	10	11	6	8	2	4	6	9·2
9–10	4	7	3	12	12	5	12	11	6	14	6	20	11	9	16	24	3	7	13	4	4	4	17	11	10	7	6	1	6	5	9·0
10–11	3	5	4	11	12	6	11	13	4	22	8	21	13	9	17	20	2	9	14	5	3	5	18	18	10	10	6	1	12	5	9·9
11–12	3	5	4	11	11	7	9	5	4	20	7	22	15	9	20	23	4	8	16	4	4	3	18	16	9	13	6	1	8	5	9·7
Total Daily Movement.	178	164	225	218	368	257	324	408	247	119	363	225	410	407	273	522	216	311	308	185	162	108	320	259	342	272	290	81	78	253	10·9

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

1866. Day of Month.	Reduced to mean of day. Barometer, corrected to Temp. 32°.*	Temperature of Air.	Calculated. Dew Point.	Relative Humidity.	Tension of Vapour.	Temperature of Air. Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9·30 A.M.	Daily Range.	At 9·30 A.M., 2.30 P.M., and 5 P.M., respectively. Proportion of Sky clouded.	Direction of Wind.	Rain—read at 9·30 A.M.
	inches.	°	°		inch.	°	°	°	0—10		inches.
Dec. 1	29·782	33·4	28·1	·83	·209	35·6	27·6	8·0	10, 10, 10	E, E by N, E.	0·000
„ 2	...	...	...	...	...	47·0	33·1	13·9	...	... ...	·183
„ 3	29·782	49·5	47·5	·93	·367	52·6	33·8	18·8	9, 10, 10	SW by S, SW, SW.	·062
„ 4	29·717	53·7	51·1	·92	·423	55·4	46·5	8·9	10, 10, 10	SW, SW by W, SW.	·162
„ 5	29·778	53·1	53·0	·99	·415	54·6	52·7	1·9	10, 10, 10	SW by S, SW, SW.	·110
„ 6	29·746	52·5	50·0	·92	·406	56·6	46·5	10·1	10, 10, 10	S by W, SSW, SW.	·419
„ 7	29·520	46·6	39·3	·78	·332	49·3	47·9	1·4	10, 7, 2	SW by S, W by S, WSW.	·036
„ 8	30·326	38·8	32·0	·79	·253	44·1	36·0	8·1	0, 2, 0	W, WNW, W.	·019
„ 9	...	...	...	...	...	53·6	24·3	29·3	...	... ...	·010
„ 10	30·097	44·7	39·3	·83	·311	48·9	39·4	9·5	4, 7, 1	NW, NW by W, NW.	·064
„ 11	30·302	34·7	34·6	·99	·219	—	30·0	—	10, 9, 10	N by E, ENE, E by N.	·020
„ 12	29·793	52·1	48·3	·88	·401	53·4	33·0	20·4	10, 9, 10	W, W, W by S.	·140
„ 13	29·432	50·7	46·7	·87	·382	55·8	47·3	8·5	10, 10, 2	SW by S, W by S, W.	·022
„ 14	29·457	43·7	38·3	·83	·300	48·5	39·9	8·6	0, 8, 8	WSW, W, SW.	·189
„ 15	29·418	45·6	41·5	·87	·321	50·8	36·0	14·8	10, 10, 9	SSE, W, W.	·000
„ 16	...	...	...	...	...	48·3	42·1	6·2	...	... ...	·150
„ 17	30·211	47·0	45·9	·96	·337	51·6	34·9	16·7	10, 10, 10	S by W, SW by W, SW by S.	·000
„ 18	30·260	50·4	45·7	·85	·378	53·7	41·3	12·4	10, 10, 1	SW, WSW, SW by S.	·000
„ 19	30·356	44·8	35·8	·73	·312	49·7	45·1	4·6	0, 1, 0	W by N, W by N, N.	·000
„ 20	30·465	36·1	34·7	·95	·230	36·9	25·4	11·5	10, 8, 10	—, —, —.	·000
„ 21	30·318	37·1	34·6	·92	·238	39·8	26·1	13·7	10, 1, 2	WSW, SW by W, SW.	·000
„ 22	30·416	37·7	37·4	·99	·244	42·3	28·6	13·7	10, 10, 10	SW, S, S.	·003
„ 23	...	...	...	...	...	44·8	35·2	9·6	...	... ...	·010
„ 24	30·299	39·8	39·1	·97	·262	42·6	38·5	4·1	10, 10, 10	SSW, S, S.	·000
„ 25	...	...	...	...	...	47.5	34·4	13·1	...	... ...	·000
„ 26	29·976	45·9	43·2	·91	·324	49·4	38·5	10·9	10, 5, 5	SSW, SSW, SW by S.	·005
„ 27	29·857	44·6	36·6	·76	·310	47·7	43·3	4·4	1, 9, 1	W, W, W.	·067
„ 28	29·987	48·1	40·4	·77	·350	51·7	43·6	8·1	6, 9, 10	WSW, W, WNW.	·000
„ 29	29·671	48·2	42·0	·81	·351	51·3	44·3	7·0	3, 10, 9	SW, W, W by S.	·000
„ 30	...	...	...	...	...	42·5	34·6	7·9	...	... ...	·013
„ 31	29·299	31·0	28·6	·92	·192	33·5	26·6	6·9	3, 7, 2	SW by W, —, —.	·013
Daily Means.	29·930	44·3	40·5	·88	·314	...	...	10·4	...	... ...	1·697

* To obtain the Barometric pressure at the sea-level these numbers must be increased by ·037 inch.

HOURLY MOVEMENT OF THE WIND (IN MILES), AS RECORDED BY ROBINSON'S ANEMOMETER.—DECEMBER, 1866.

Day. / Hour.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Hourly Means
A. M. 12–1	5	9	20	24	19	7	26	10	0	17	4	4	18	10	8	18	4	8	19	1	6	1	2	5	1	18	34	10	16	16	4	11·1
2	5	5	25	21	14	9	26	8	1	17	1	5	16	10	9	18	4	9	20	2	7	0	2	5	3	19	25	11	16	14	6	10·8
3	5	3	20	23	13	8	21	10	2	19	2	6	20	12	7	17	5	11	20	1	7	0	1	4	2	17	21	11	12	13	5	10·3
4	4	2	13	24	14	7	22	9	3	13	2	6	22	14	8	22	3	12	21	1	5	1	2	2	3	19	23	11	12	12	5	10·2
5	2	5	10	27	13	8	20	10	5	11	1	10	23	13	7	17	2	12	19	1	4	1	4	1	2	15	25	11	15	12	6	10·1
6	4	5	10	24	14	5	20	6	5	12	2	10	19	11	5	17	2	13	19	0	4	1	3	1	1	13	20	12	12	12	5	9·2
7	6	5	10	26	16	8	24	9	5	11	2	10	21	9	6	21	2	13	16	0	3	1	4	3	4	11	18	12	13	14	4	9·9
8	9	6	13	26	14	7	22	9	6	11	4	11	20	9	5	22	1	10	17	0	2	0	3	2	2	9	19	10	10	14	4	9·6
9	8	7	11	27	15	6	23	7	10	9	4	18	22	9	4	13	3	10	10	0	2	0	4	7	4	6	15	11	15	12	4	9·5
10	10	7	17	25	18	6	19	5	11	11	3	12	20	10	6	12	7	10	10	0	3	1	3	9	5	17	16	12	12	14	3	10·1
11	10	7	19	22	18	14	23	10	16	9	6	17	22	12	9	13	8	12	11	1	6	1	4	9	7	10	19	11	19	16	2	11·7
12	8	8	22	26	25	21	23	10	21	10	1	19	26	11	13	15	7	11	12	2	5	3	5	6	5	8	18	17	18	18	4	12·9
P. M. 1	10	7	25	25	24	23	26	10	25	13	2	17	25	10	10	15	12	14	14	1	4	1	7	6	10	10	12	21	17	18	3	13·5
2	10	5	24	27	20	25	25	10	23	10	2	21	26	13	8	12	10	16	10	1	5	2	5	5	10	14	19	21	17	20	0	13·4
3	10	4	21	27	21	25	26	8	25	9	1	18	22	16	9	9	12	19	7	1	6	3	7	4	12	13	17	22	19	19	2	13·3
4	8	3	21	27	19	25	25	5	25	4	3	16	19	10	18	27	8	16	4	2	4	1	4	8	12	14	17	19	20	15	1	12·3
5	10	4	23	26	16	28	26	5	27	4	2	16	16	10	26	6	10	16	4	1	3	1	4	7	14	12	17	17	23	14	0	12·5
6	7	5	27	27	10	30	21	4	26	4	3	15	11	10	21	6	7	10	2	2	3	1	4	6	14	14	12	18	19	10	1	11·3
7	8	12	29	30	13	30	23	2	27	3	4	13	11	12	17	7	9	10	3	1	2	1	5	3	12	21	14	18	23	9	1	11·6
8	9	15	26	29	6	31	19	2	25	2	2	10	10	12	20	7	10	12	5	1	2	1	7	2	15	22	15	15	23	9	0	11·8
9	6	14	25	24	4	32	12	1	26	4	1	10	12	11	17	5	7	8	5	2	2	1	2	1	13	24	15	14	23	7	1	10·6
10	6	10	18	21	10	34	13	2	25	3	1	10	12	11	20	5	10	14	1	3	2	1	4	1	14	33	14	15	19	7	1	11·0
11	9	13	26	21	8	33	12	2	21	4	1	11	11	8	20	4	11	16	2	6	3	1	8	2	18	32	14	14	19	5	2	11·5
12	7	13	22	21	7	29	9	1	17	4	2	16	13	8	17	4	12	20	2	3	2	2	6	1	18	35	15	12	15	7	4	11·1
Total Daily Movement.	176	175	477	600	351	451	506	155	377	214	56	301	437	261	290	292	166	302	253	33	92	26	100	100	201	406	434	345	407	307	168	11·2

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

MONTHLY AND ANNUAL MEANS FOR THE YEAR 1866.

Month.	Barometer, corrected to temp. 32°.*	Temperature of Air.	Dew Point.	Relative Humidity.	Tension of Vapour.	Daily Range.	Total Fall of Rain.
	inches.	°	°		inch.	°	inches.
January	29·860	42·7	37·9	·85	·294	9·7	3·384
February ...	29·700	41·8	35·9	·81	·286	10·5	3·718
March.........	29·613	40·1	34·0	·81	·271	11·6	1·150
April	29·866	47·3	40·1	·80	·348	14·5	1·807
May............	29·941	50·2	38·4	·67	·382	17·9	1·319
June	29·909	59·4	52·4	·76	·521	18·3	3·161
July...........	29·914	61·1	51·4	·73	·551	17·5	1·930
August ...	29·776	58·4	50·8	·74	·498	16·2	2·435
September.	29·756	55·2	49·6	·83	·447	12·4	3·588
October ...	30·061	51·4	47·9	·88	·397	11·8	1·633
November .	29·959	44·8	39·3	·83	·320	12·6	1·275
December..	29·930	44·3	40·5	·88	·314	10·4	1·697
Mean	29·860	49·7	42·8	·80	·386	13·6	27·097

* To obtain the Barometric pressure at the sea-level these numbers must be increased by ·037 inch.

TABLE SHOWING THE MEAN VELOCITY OF THE WIND FOR EACH HOUR OF THE DAY IN THE DIFFERENT MONTHS OF THE YEAR 1866 (IN MILES PER HOUR).

	A. M.												P. M.												
Hour.	12 to 1	to 2	to 3	to 4	to 5	to 6	to 7	to 8	to 9	to 10	to 11	to 12	to 1	to 2	to 3	to 4	to 5	to 6	to 7	to 8	to 9	to 10	to 11	to 12	Mean.
Jan.	13·0	12·6	13·3	13·5	13·9	13·4	13·7	14·6	14·9	15·6	16·0	17·3	18·3	17·4	16·7	14·6	13·4	13·0	13·7	13·9	13·8	13·7	14·7	12·4	14·7
Feb.	12·1	11·5	10·9	12·0	11·8	11·2	11·1	11·2	12·3	14·1	15·9	16·7	19·8	19·6	18·5	17·6	1·63	14·0	13·7	13·8	12·8	12·7	13·2	11·4	13·4
March ...	8·2	9·0	9·0	8·6	8·7	8·9	9·6	9·9	10·9	12·6	14·7	15·0	16·7	16·6	15·6	15·2	15·0	11·9	11·9	10·2	9·5	9·4	9·7	8·9	11·5
April	9·3	9·0	8·6	8·9	9.1	9·2	9·7	11·5	13·4	14·1	16·0	16·1	17·1	17·2	17·2	16·7	17·0	14·7	15·3	11·8	11·6	10·9	11·7	10·1	12·9
May	8·2	8·0	7.4	7·0	7·4	7·2	8·9	11·1	11·4	12·4	12·8	12·7	13·0	14·6	14·0	14·8	14·8	13·5	12·6	11·8	9·4	8·5	8·7	7·9	10·8
June......	6·8	6·0	5·8	5·8	6·0	6·3	7·8	8·6	9·6	10·0	12·9	13·2	13·9	13·6	13·7	12·8	13·9	11·9	11·2	9·2	8·4	7·4	7·6	6·4	9·4
July	6·4	6·7	6·8	6·3	6·2	6·2	7·8	9·5	10·2	10·2	11·3	11·2	12·2	12·5	12·6	12·6	12·2	10·7	10·4	9·3	7·8	6·8	7·2	6·1	9·1
August...	8·2	8·0	7·3	7·3	7·0	6·5	7·6	8·6	9·4	10·3	11·1	10·8	11·8	11·2	11·9	12·8	12·6	11·6	10·2	9·9	8·6	8·2	8·0	7·7	9·4
Sept. ...	9·9	9·6	9·5	9·4	8·6	8·5	9·3	10·4	12·0	13·4	14·0	14·4	15·5	14·3	13·5	13·6	14·0	11·7	10·4	10·7	10·9	9·8	10·4	10·4	10·9
Oct.	6·9	6·4	6·3	6·6	6·6	6·5	6·6	7·0	8·2	8·4	9·6	10·8	11·4	10·7	10·0	8·9	7·9	7·7	7·5	7·5	7·2	7·2	6·9	6·9	7·7
Nov.......	10·0	10.3	10·0	10·4	10·3	9·4	10·2	11.3	11·7	11·7	13·5	15·1	14·7	13·3	13·3	11·4	10·6	9·2	8·9	10·1	9·2	9·0	9·9	9·7	10·9
Dec.	11·1	10·8	10·3	10·2	10·1	9.2	9·9	9·6	9·5	10·1	11·7	12·9	13·5	13·4	13·3	12·3	12·5	11·3	11·6	11·8	10·6	11·0	11·5	11·1	11·2
Mean....	9·2	9·0	8·8	8·8	8·8	8·4	9·3	9·4	11·1	11·9	13·3	13·9	14·8	14·5	14·2	13·6	13·4	11·8	11·3	10·9	10·0	9·5	9·9	9·9	11·0

LIGHT SPOTS IN THE LUNAR NIGHT.—THE CRATER LINNE.—OCCULTATIONS.

BY THE REV. T. W. WEBB, A.M., F.R.A.S.

AFTER a long interval, we return to the study of some of the details of the surface of our satellite. In following the arrangement of Beer and Mädler we have last described the Lunar *Alps* (19 in our Index-Map) and should next in order proceed to the W. extremity of the great *Mare Imbrium* (I); but that we ought not to pass without remark the site of a singular luminous appearance described by Schröter with much precision; of which, as might have been expected, no notice whatever has been taken by Beer and Mädler, but which we think of sufficient interest to lay at some length before our readers, together with some other instances of the same nature.

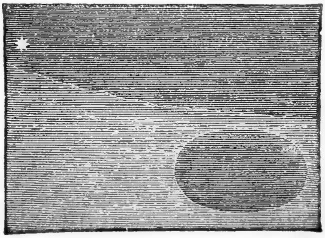
The earliest mention of any luminosity on the unenlightened part of the moon seems to have been that of Sir W. Herschel, who perceived in 1783 and 1787, three patches of feeble light, which he considered to be volcanoes in eruption. As there was much in favour of the possibility of such an event, and nothing to contravene it, the assertion was generally received. Schröter, who had in 1784 independently noticed with a 4-foot Newtonian, made by Sir W. Herschel, the visibility of the brilliant crater *Aristarchus* (43) on the dark side of the moon, and had perceived that it shone simply by the reflection of the earth-light, was thus induced to make a careful revision of many parts of the unenlightened hemisphere, when sufficiently in front of the earth to receive a considerable share of our reflected rays; and his attention was especially directed to the neighbourhood of the great wall-plain *Plato* (38)—a little E. of the district we have last described—by the circumstance that in Jan. 1788, Fischer at Mannheim had perceived a feeble illumination which he had, erroneously as it seems, referred to that region. Schröter had no difficulty in recognizing three phosphorescent spots; measurement and allineation enabled him readily to identify them with the large and very luminous craters *Aristarchus* (43), *Manilius* (24), and *Menelaus* (15); * and no reasonable doubt remained that these were the three supposed volcanoes of Herschel. But nothing was perceptible in the vicinity of *Plato*. In other directions, towards the E. limb

* B. and M. have preferred, for what reason does not appear, *Aristarchus*, *Copernicus* (30), and *Kepler* (41). The idea of these eruptions, however, was not at once abandoned. Fallows, who died at the Cape in 1831, believed that he had seen them.

of the moon, he picked up from time to time faint glowing specks, and was at much pains to identify them, and to detect the cause of their apparent variations, and after a first precipitate inference of volcanic activity, was at length led to the important conclusion, that portions of the lunar surface subtending only a few seconds, may be either entirely inconspicuous, or faintly luminous, or strongly glittering, according to the angle of illumination, and that consequently a distinct luminosity may be sometimes perceived in a spot in the earth-shine, which has but a dusky aspect even under the solar rays falling on it at a different angle. The effect therefore of the earth's reflection is directly comparable only with the aspect of the full moon; and so far, there would be no reason to ascribe any other origin than the reflection of the earth-shine, to the generality of the luminous specks visible on the dark hemisphere. And in this conclusion Bode and other astronomers acquiesced. There were, however, some residual phenomena not thus entirely explained, and Schröter thought that not only had atmospheric differences to be allowed for in the usual way, but also their indirect action in influencing the reflective power of the earth, and that beyond this, there must be some modifying cause on the surface of the moon or in her atmosphere, to account for certain variations which he perceived. Without anticipating some of his observations on the neighbourhood of the E. limb, we may give his example, that after a familiar acquaintance of two years with the aspect of *Manilius* and *Menelaus* under doubly reflected light, when he usually found *Menelaus* considerably the larger and brighter of the two, in a subsequent set of six observations in 1790, *Manilius* appeared to him not only larger, but at least as bright, and in some instances actually brighter than its neighbour. As to the latter part of these inferences, astronomers may entertain different opinions; and some would claim an allowance for more practised ocular judgment, such as has been known to influence progressive estimates of the brightness of nebulæ or the distances of double stars. But there is always something interesting and instructive in following the mental processes of any clear and consecutive thinker, who is not afraid of describing his own successive impressions or of retracting his too hasty conclusions. And besides this, facts are often gradually evolved out of seeming confusion and misapprehension, and sometimes what has been suffered to drop through, in hastily grasping at some tempting simplicity of explanation, has been subsequently found essential to the full apprehension of a truth more complex than it may have appeared. It is not impossible that the present very interesting investigation into the state of the crater Linné, which we owe to the great observer Julius Schmidt of Athens, may lead to a

review of some of the neglected and perhaps undervalued speculations of Schröter.

However, we must now see what happened to this astronomer, 1788, Sept. 26, 4h. 25m. in the early morning, when he often rose to carry on his investigations, in the spirit of old Hevel's resolution, "As far as I am concerned, I will not suffer sleep to be so dear to me, that the investigation of so great a matter should not be dearer." It was 3½ days before the new moon: the sky was so clear that the streaks of Tycho were distinctly visible in the dark side: and with a fine 7-foot Newtonian made by Herschel, and a power of 161, he examined the region of *Proclus* (12), as the second point in reflective power on the moon. Notwithstanding however its favourable position on the hemisphere, and its intensity in the full moon, he could not find a trace of it. The most probable explanation of this failure—the minute breadth of the ring, which is the only reflective part*—did not occur to him, and he was proceeding to scrutinize the neighbourhood of the N. limb, when he was struck all at once by the appearance of a small whitish spot of somewhat misty light, about 4″ or 5″ in diameter, like a star of the 5th mag. seen with the naked eye, which had a faintish radiating glimmer around it, and on a small scale looked much like the spot *Kepler* (41) as viewed on the enlightened side with a moderate power. To preclude any deception, he traversed several times the rest of the unenlightened disc, and recognized its features, as before, with much distinctness, but as soon as ever this N. part was brought into the field, again repeatedly found the same luminous spot, sometimes brighter, at others more faint, but always distinct, and in an unvaried position. Previous to an intended measurement with his projection machine† he estimated its place to be very near the edge of the dark *Mare Imbrium*, and about 1¼ to 1⅓ diameter, or 1′ 16″ to 1′ 20″ distant from a dark spot which he at once recognized as *Plato*.



This estimation he repeated and confirmed several times while he kept constantly under review the other features of the dark disc. But now his spot was becoming at intervals indistinct—then uncertain—and soon after totally disappeared. To obtain

* See INTELLECTUAL OBSERVER, vii. 258.

† This was a simple measuring apparatus always used by him in selenography, and consisting of a board covered with white paper ruled in squares, and placed at a suitable distance, which was viewed with one eye, while the lunar surface was looked at with the other. A modification with circular discs, for measuring planets, has been already described. INTELLECTUAL OBSERVER, viii. 458.

more light, as the object was sufficiently large, he changed his power for one of 95, but could only now and then perceive an extremely feeble and quite uncertain vestige of it, and after an observation of more than a quarter of an hour, he found it had entirely vanished. Nothing in our own atmosphere could have produced this luminosity, as during the course of nearly half an hour, it had kept its position unmoved, and after its disappearance *Manilius* and *Menelaus* and the other features of the dark side were as visible as before: it must therefore, he concluded, have been an actual development of light either upon the surface or in the atmosphere of the moon. On comparing its situation with a sketch of the vicinity taken some time before, he found that it concurred with the region of the lunar *Alps*, which he resolved to study with renewed energy. Here, Oct. 8, he perceived, just to the E. of the great peak of *Mont Blanc* (INT. OBS., ix. 63), and enclosed by the lower ridges of that mountain mass, a round, black, defined spot of 6″, like a crater without a ring, all lying in shade, which he never recollected to have seen before: and the measurement of whose position agreed, as nearly as could be expected, with his former estimate. The two following evenings it appeared as a very flat depression, of a darker grey than the *Mare*. Oct. 11, the grey was only that of the *Mare*, with a little central darkness, which, 13, had disappeared. 14 and 15, including the full moon, the same. Nov. 8, it was seen again as a round black crater-like hole, though the illumination and libration were nearly the same as on Oct. 9, when it was only dark grey. 20, though near the line of lunar sunset, and fully exposed to the solar rays, it appeared grey and flat. Dec. 11, the site appeared indistinct in the 4-foot reflector. He details these and many other observations at much length to strengthen his position that something more than mere difference of illumination was concerned in these variations. In this he may probably have been mistaken; a long smooth slope slightly inclined to the horizon would change its aspect so entirely from very trifling variations in the angle of light incident in one direction, and would be so little affected by corresponding variations of illumination from the opposite side, that, in connection with changes of libration, this cause alone might suffice for all his recorded phenomena; yet still they are instructive enough in their own way to deserve this passing notice: and had any regularly-formed crater since been visible upon the spot, we should have acknowledged an evident analogy with the processes now supposed to be in operation in the crater *Linné*. Subsequently (1789, Apr. 5), he was much struck by the discovery of a minute bright crater not more than 10″ or 12″ E. of the supposed dark opening, just where the furthest spur

of *Mont Blanc* in that direction sinks into the plain; and by finding another well-known crater (*Plato* K. of B. and M.), not quite so small, lying a little way out in the plain in the prolonged direction of the *Wedge-shaped Valley* (Int. Obs., ix. 61), not only somewhat enlarged, but doubled by the encroachment of a smaller companion on its S.E. side—a feature quite new to him, though he had drawn it twice under entirely dissimilar illumination, with the interval of a year. Besides this, though the weather was not favourable, several other very small objects were perceived for the first time within a short distance, while a known minute crater in the plain, S.E. of *Mont Blanc,* could scarcely be identified as such.* He was naturally much surprised at all this, in a spot which he had 16 times during half a year been scrutinizing under various illuminations with especial care; and while holding to his idea that many such apparent changes were connected with variations in a lunar atmosphere, he thought that on the whole, taken in connection with the luminous appearance in this very region, some eruptive action might probably be indicated.

The site of this phosphorescence, so to speak, naturally attracted his continued attention; but never could he trace a vestige of it again. He waited for the time when the moon should occupy a corresponding position, which happened more than a year afterwards, 1789, Oct. 15. The circumstances were very favourable: the old features were all discernible, and even a very faint shining could be made out on the site of *Proclus,* but where the little star-like speck had vanished, the gazing of an hour brought out so feeble a trace of a glimmering point at times, that it was quite uncertain, and probably only the illusory result of an over-taxed vision. Had the little crater at the E. foot of *Mont Blanc* been subsequently found of larger size, he might, he says, have referred this flicker to the closing scene of an eruption there. But in this he would have been mistaken. The maps of B. and M. and Lohrmann do not contain it, and I do not recollect to have ever seen it. However, 1832, Apr. 9, I made out distinctly, with only 3 inches of a Barlow achromatic, the double crater *Plato* K, and suspected a similar companion to a little crater near at hand, half way between it and the wall of *Plato* (designated *Plato* i by B. and M). This suspicion was converted into a certainty with a $3\frac{7}{10}$ inch aperture, 1836, May 25, when I was struck with the curious aspect of the two adjacent pairs, and made a note that "this object surely could not have escaped Schr.'s observations had it existed in his time." We learn something

* At another time he saw this as a hill, and curiously enough it is so represented in the maps of Lohrmann and B. and M. The "Sections" of the former do not extend to this region.

from experience. I think I should hesitate in making any such assertion *now*.

On the last morning Schr. found two other luminous specks, where he had never perceived anything whatever on former occasions: one, W. of *Menelaus,* and very similar in aspect to *Manilius,* falling on the site of the *Promontorium Acherusia* (INT. OBS., viii. 30) and *Taquet,* (a small bright adjoining crater); the other on the opposite side of the *M. Tranquillitatis,* at the *Mons Herculis* [qu: Prom. *Heracleum*] of Hevel [*Censorinus,* 90]: and here, he believed, as in former cases, was evidence of incidental modification, as though something occasionally interfered with the uniformity of reflective power on the dark side of the moon. Certain localities, it might be supposed, were liable to atmospheric obscuration, which could, he thought, be often traced, in the non-visibility of minute objects towards the lunar sunset, and which might be continued, or might be more likely to occur, during the lengthened night. And he mentions the curious fact, that during a very favourable view, 1790, Jan. 17, he not only noticed (what has already been mentioned) that the relative brightness of *Manilius* and *Menelaus* was interchanged, but that the considerable luminosity just mentioned on the site of *Taquet* could not be perceived again, excepting as a very minute point as bright as *Manilius* or *Menelaus* during the first 15m., of which afterwards nothing could be seen; that on the other side of the *M. Tranquillitatis* [at *Censorinus*] nothing more than a very slight increase of brightness could be at times perceived; and that in another direction [that of *Dionysius,* 25] he caught, but twice only, a very minute point, brighter than either *Manilius* or *Menelaus,* which he could not recover again. In all this he found, of course, the confirmation of his hypothesis. Shall we accept it as such, or shall we ascribe it to mere eye-weariness, and anxiety, and prepossession?—misrepresentation, no one that knows his writings would for a single instant impute to that honest man. We would answer, that we leave it to time to discover the value or the error of his observations and inferences. Some years ago we might have been disposed, like B. and M. to pass them by in silence; the new course of selenological investigation seems to demand a fuller treatment of a subject more difficult than it might at first appear.*

The observations of 12 subsequent years never renewed again to Schr. the illumination on the E. side of *Mont Blanc*; but the use of larger apertures—his 13 ft. reflector had about $9\frac{1}{2}$ inches, and his 27ft., $19\frac{1}{6}$ inches English measure—fully confirmed his previously formed opinions, and he has recorded the following interesting and final addition in his second volume.

* See especially INT. OBS. vii. 54, 55; viii. 295.

1794. Apr. 2, while the 13 ft. telescope was showing him, as might be expected, a large increase of faint specks in the earth-shine which could not be reached by his smaller instruments, he perceived in the region of *Agrippa* (26) and *Godin* (27) an extremely fine point of very bright light, intense enough to distinguish itself from all the rest, and to resemble a minute glimmering star; and which struck him so much the more, since it was entirely new to him. Its aspect was not that of earth-light, and its incidental nature was proved by the fact that a full quarter or half an hour later, when he wished to observe it again, though circumstances were equally favourable, he could find it no more with any certainty. With straining vision he imagined that he perceived a similar one further W., but it was not clearly distinguishable. Such a phenomenon he was then disposed to think might be readily referred to some artificial cause, since terrestrial fires of considerable size would no doubt be visible from the moon; it would seem, however, more consistent with our other knowledge to refer it to a volcanic origin.*

It will excite no surprise in the minds of those who have attended to the subject, that these observations were ignored by B. and M., viewed, at least, as the mere effect of more favourable circumstances and curtailed periods of observing. But the day has gone by, we hope, for such a superficial treatment of the subject; and the question has recently been revived in a very interesting form.

1865. Jan. 1. Mr. C. Grover, of Chesham, an observer whose name has already been made known to our readers, was looking at the moon at 6h. p.m., the sky being very clear, with an excellent 2-inch achromatic, when he perceived a little speck of light, which was very distinctly seen like a 4 mag. star very slightly out of focus, with a little light haze around it. Powers of 50, 65, and 80 were used, but the first was preferable. It was in view for fully half an hour, without change, and showing a perfectly steady light. He most carefully studied its position, and, the outlines of *Plato* and the *M. Imbrium* being discernible, found that it was close under the E. foot of the *Alps*, very near the mouth of the wedge-shaped valley: and consequently either exactly on the site of Schr.'s phenomenon, or so near to it that the coincidence is at any rate most remarkable. The epoch of Schr.'s observation was 3d. 12h., before new moon; that of Grover's 3d. 21h. after, and the site of the luminosity lying near the first lunar meridian, it is obvious that, allowance being made for probable dissimilarity of libration, the distance of the spot from the terminator on the

* A naked-eye observation of a bright spot, recorded in Phil. Trans. 1794, was evidently an occultation of Aldebaran, disguised by irradiation.

two occasions, though in opposite directions, would not be materially different. Taking into account the disparity of optical means, it must have been very much more luminous in the latter observation. The site deserves an especially careful scrutiny under varied solar illumination.

But this, though the whole of the evidence as to this particular district, is not all that has recently come before us.

1865. Nov. 24, about 6½h. p.m, the Rev. W. O. Williams, of Pwllheli, N. Wales, perceived, with a $4\frac{1}{16}$ in. object-glass, "a very pretty speck of light * * very much like a star of the 8th mag., but quite distinct and clear," which he observed for about $1\frac{1}{3}$h. with different eye-pieces, and saw better with 60 and 80 than with higher powers, though it was well seen even with 200. He showed it also to a friend, and one of his daughters found it quite independent of his directions. From careful allineation he believed its site to be at or very near *Carlini* (128), a small crater in the *M. Imbrium*, a neighbourhood which likewise ought to be studied in detail. As the moon was on this occasion 6¼ days old, the brightness of the spot must have been very considerable to have made itself so readily distinguishable.

A review of the whole of these statements seems to establish the fact that outbursts of native light are visible from time to time on the night side of our satellite. At present, it can hardly be said that the attempt to identify their sites with foci of volcanic action has been unsuccessful, because an attempt has never hitherto been made in a manner likely to ensure success. Schröter's investigation was carried on upon unknown ground: his larger crater was probably not a crater at all; the novelty of his small ones rests on evidence which would prove too much; and till of late the inquiry has been in abeyance. It should not remain so longer.

THE LUNAR CRATER LINNÉ.

Since the truly remarkable announcement in our last number by Schmidt, of the change in the crater *Linné*, neither the state of the air, nor the position of the terminator have been as favourable as might be wished for the careful examination of this object. However, the following observations may be thought sufficiently interesting for publication, till such time as many of our readers, we hope, will be able to do better by it themselves.

1866. Dec. 13, 8h. Silvered reflector, 9¼ inches, by With, power 240. Sky clear, but moon very low, and definition tremulous. Terminator about 1½ diam., E. of *Aristoteles*; 2 diams., E. of *Eudoxus*, and through E. edge of *M. Serenitatis*. "About ⅓ of the way from a marked high mountain on N.

shore of *M. Seren.* to *Sulpicius Gallus** is a minute darkish looking crater; it is not well seen under these circumstances, but there can be no doubt as to its nature. This I presume is *Linné,* as I can trace no crater anywhere else. At some little distance S.E. there is an ill-defined whitishness on the floor of the *Mare.*" Such was my record at the time; but on subsequently examining the map of B. and M. I was much struck by finding that my crater was unmistakeably *Linné* B, and that the site of *Linné* was *occupied by the whitish cloud.*

1866. Dec. 14. 6h. Same telescope and power: bad definition. Terminator through centre of *Archimedes.* The whitish spot in the place of *Linné* is barely as large as *Sulp. Gallus;* it is the most conspicuous object in E. half of *M. Seren. Linné* B not visible.

1866. Dec. 25. 19½h. Same telescope, power 170. Fine definition, too much *rippled over* for distinctness. *Linné* a very conspicuous white nebulous patch, containing some very indistinct and almost doubtful marking within it; I forget whether dark or light, but believe the latter: not such, however, as to suggest the idea of a crater under present definition. It is about equal to, but not quite so bright as, the larger of two white spots just N.E. of *Sulp. Gallus. Linné* A, B, d, and an unnamed hollow ⅓ of the distance from *Linné* B to *Calippus* K, were all very distinct as craters. (This, it will be observed, was in waning illumination.)

1867. Jan. 12. 5h. 35m. Same telescope, powers 212, 240. Unsteady and inferior definition. Ring of *Cassini* half in light, so that shadow of a peak in it fell on ring of *Cassini* A. *Theætetus* half touched by sun. On the site of *Linné,* nothing but a small ill-defined whitish cloud, not quite so large as *Sulp. Gallus.* There appears to be some slight marking as from a small shadow towards its centre, but far too indistinct to say whether caused by hill or hollow. Three small craters with dark interior shadow are quite distinct in moments of better definition. I believe they were *Linné* A, B, and the unnamed one already mentioned, but I did not examine the map till clouds had come on. The white cloud was by no means bright or conspicuous, though perfectly distinct.

The speculum used in these observations, though its figure has not received its final touch, gives very sharp and clear definition, and separates γ^2 Andromedæ with great ease. The value of the powers is at present only approximate.

It will be, of course, most desirable to watch for the moment when *Linné* has just entered into sunshine, and its relief comes out in light and shade. It would be troublesome

*A small bright crater in the *Mare,* close to the S. shore, some distance E. of *Menelaus.*

to compute this epoch accurately, but it may assist our preparation to observe, that two evenings previous to such a presentation, the E. side of the great crater *Hercules* (5) will be upon the terminator, which will pass through *Plinius* (13) the next day.

In addition to the valuable information contained in our last number, our readers may be glad to have the precise wording of the original observations laid before them, as far as they lie within my reach. Schröter, 1788, Nov. 5, describes the course of his 6th ridge in the *Mare,* from a small crater on the S. shore (b *Sulp. Gall.* B. and M.) northward to another somewhat uncertain one v, "about equally large, but quite flat, appearing like a white, very small, round speck," and thence to g, "a not sharply-defined dark spot, which during that observation had only some $\frac{1}{2}°$ light, and consequently struck the eye as considerably darker than the rest of the plain, and was somewhat indistinct, from lying very close to the terminator." The choice of the site of *Linné* lies between these two; from a comparison of Schr.'s drawing with B. and M., I incline to v; and should this be correct, its appearance then was not very unlike its present, excepting that he makes no mention of the whitish cloud.—In Lohrmann's Section IV. (1824) and his map (1822 to 1836) it is a distinct crater. In his text it is stated that he measured its position, and that it has "a diameter that amounts to somewhat more than one (German) mile, is very deep, and can be seen in every illumination."—B. and M. call it "the deep crater *Linné;*" they measured its position seven times, gave it 1·4 mile in breadth and 6° of brightness, and remark that it is ill-defined in full moon; but without any mention of the white cloud which is now so conspicuous in high illumination.*

OCCULTATIONS.

Feb. 9th, μ Piscium, 5 mag., 7h. 38m. to 8h. 35m.—12th, θ^1 Tauri, $4\frac{1}{2}$ mag., 12h. 50m. to 13h. 38m., its companion θ^2, $4\frac{1}{2}$ mag., 13h. 0m. to 13h. 32m. B. A. C. 1391, 5 mag., 13h. 37m. to 14h. 26m. (worth sitting or getting up for).—13th, 111 Tauri, 6 mag., 11h. 2m. to 12h. 6m. 117 Tauri, 6 mag., 12h. 45m. to 13h. 35m.—16th, 29 Cancri, 6 mag., 12h. 13m. to 13h. 19m.

* [Having several times looked at *Linné* with a very fine $6\frac{1}{2}$-inch reflector by Browning (with With's mirror), we should have preferred calling its present appearance a *whitish spot.* It does not, to our eyes, sufficiently differ from other whitish spots to be distinguished from them as a "cloud."—Ed.]

THE FOSSIL FOREST OF ATANAKERDLUK.

THE *Archives des Sciences* (No. 107) contains a report of a paper by Oswald Heer, on the fossil forest of Atanakerdluk, in North Greenland, from which the following particulars are taken.

The forest in question is situated in lat. 70° N., and numerous specimens obtained from it were brought to England, and from thence sent for examination to M. Heer. All the indications show that the trees grew in the place in which they have been found, and many of the leaves are so well preserved as to exhibit fragments of insects on their surface.

The forest of Atanakerdluk probably dates from the commencement of the miocene period, for out of sixty-six species of plants recognized in it, eighteen belong to the miocene formation of Central Europe, nine of which were widely diffused, and are met with in the two divisions of the *molasse.* These last are as follows: *Sequoia Langsdorffi, Taxodium dubium, Phragmitis Œningensis, Quercus Drymeia, Planera Ungeri, Diospyros brachysepala, Andromeda protogæa, Rhamnus Eridani,* and *Juglans acuminata.* Some species, on the contrary, have not been found in the upper *molasse,* such as *Sequoia Couttsiæ, Osmunda Heerii, Coryllus Mac Quarrii, Populus Zaddachi.*

The discovery of this fossil flora shows that the north of Greenland formerly enjoyed a much higher temperature than at present. When M. Heer arrived, from a study of the Swiss miocene flora, at the conclusion that the climate of that country must formerly have been almost tropical, his opinions were assailed, and it was contended that the plants in question might have been able to withstand a lower temperature than their living representatives. This objection, of slight value in face of the evidence adduced by M. Heer, is completely disposed of by the discovery of the ancient flora of Greenland.

A great forest in the 70th parallel of latitude vividly strikes the imagination, when we reflect that all arborescent vegetation has disappeared from those regions; and we are still more astonished when we ascertain the sort of trees that formerly shaded their soil. It is from 10° to 20° more south that we must now seek their living representatives, such as the *Sequoia* now found in California, which compares with the two fossil species of the Greenland forest. A *Salisburea* which once lived there is now represented by a single species, which grows in Japan. Four species of oaks grew in this forest; the *Quercus Drymeia,* which had an evergreen foliage; the *Q. Green-*

landica, with leaves six inches long; another large-leaved oak, *Q. Olafseni*; and the *Q. atava*, which resembles our common oak. Here also abounded plane trees, magnolias (*M. Inglefieldi*), walnuts (*Juglans acuminata*), an evergreen plum (*Prunus Scottii*), a Planera,* etc. In the midst of these trees grew many shrubs, a hazel nut, an ivy, three briars, and an *Andromeda*,† while ferns carpeted the ground.

All these genera are now represented by species much allied to the old Greenland flora; but there are some which exhibit divergent forms, and whose relation with existing species is more or less doubtful—these are a *Zamites*, a *MacClintockia*, and the *Daphnogene Kanii*. This last is a green plant, with a thick leathery leaf, supported by a petiole nearly a foot long. The *MacClintockia*, with its leathery leaves, more or less lanceolate, entire, or denticulated, having from three to seven veins (*nervures*), forms an entirely isolated genus, of which the three species described appear to belong to the family of the *Proteaceæ*. The *Zamites arcticus* had its leaves divided into small thin straps, and did not exceed the dimensions of a shrub. As these plants have no living analogues, we cannot tell the temperature necessary for their development, but green plants with thick leathery leaves appear always to belong to a tolerably southern climate.

If we find that the *Sequoia Salisburea*, and the *Quercus Drymeia*, and *Olafseni* grew in the 70th parallel of latitude, it is natural to suppose that planes, beeches, pines, and nut-trees extended still further north, and perhaps reached the Pole. This inference is supported by the fact that in latitude 78° the miocene flora includes the plane, the hazel, the beech, the pine, and the Taxodium of Atanakerdluk. The masses of petrified wood found by MacClure and his companions in latitude 74° need no longer astonish us. They afford another proof that forests formerly covered vast spaces which are plains of ice.

So many circumstances influence the development of plants, that it is difficult to fix the temperature of the Greenland climate at this forest epoch. The *Sequoia Langsdorffi* formed a great part of the Atanakerdluk forest, whole branches have been recovered, and each fragment of rock bears its imprint. It played an important part in the miocene flora; it is found in the banks of the Mackenzie, in the Rocky Mountains, and, in Europe, Italy has furnished specimens. The *S. sempervirens*, which may be regarded as its descendant, forms in California great forests, which extend from Mexico to

* "Planera trees, natives of Asia and N. America, belonging to the *Ulmaceæ*, and closely allied to the elms."—See *Treasury of Bottany*.

† A genus of Ericaceæ.

the 42°. It requires 15° to 16° (about 60° to 61° F.) of summer heat to live, and 18° to mature its fruits. The lowest temperature it can withstand is —1° (30·2° F.), and the mean annual temperature must be about +9·5°. Such at least must have been the Greenland climate at its lowest limit, for the Daphnogene, the MacClintockia, and the Zamites, probably required a higher temperature. The present mean of this country being —6·3° (20·75° F.), it must during the miocene epoch have been 16 centigrade degrees warmer.

PROGRESS OF INVENTION.

FORMATION OF CRYSTALS.—There can be no doubt that time is often an essential element in the formation of crystals; this is particularly true of the diamond and other precious stones, and no doubt constitutes the obstacle to their artificial production. Hitherto, the chemist has been unable to crystallize certain compounds thrown down from their solutions; a simple means of effecting this has, however, been devised by M. Frenny. He considered that the amorphous form of precipitates arises from the rapidity with which the precipitation takes place, and therefore expected to obtain crystals by diminishing that rapidity. The result was such as he anticipated. In this way he procured crystals of the sulphates of baryta, strontia, and lead, of the carbonates of baryta and lead, etc. He obtained even crystals of quartz, which were sufficiently hard to scratch glass; but they were not pure, containing five per cent. soda and twenty-seven per cent. water.

SIMPLE FORMS OF GALVANIC BATTERY.—Hitherto the metallic solution produced in the galvanic battery, when saturated, was no longer capable of use for the purpose. It has been found, however, by M. Montiers, that such need not be the case, if we avail ourselves, in succession, of two metals having very different electro-chemical properties. As an illustration of this principle, he first places a cylinder of malleable or cast-iron in a vessel, and inside of the iron a prism of carbon; then pours in dilute sulphuric acid. The iron and graphite act as electrodes, and the electricity developed by a single couple of this kind is sufficient to keep a bell-ringing apparatus in action for a considerable time. When this battery is exhausted, he concentrates the solution of sulphate of protoxide of iron formed by it, and immerses in it electrodes, which in this case consist of zinc and carbon. The zinc is dissolved, hydrogen is liberated, and hydrated protoxide of iron is set free. The energy of this latter battery is sufficient to keep the bell-ringing apparatus in action for several months. M. Montiers also avails himself of the fact that oxide of zinc acts as a base with acids, but as an acid with ammonia and other strong bases, for the production of a very economical battery. For this purpose, he avails himself

of the carbonate of ammonia in urine, which has spontaneously decomposed, immersing the zinc in that fluid instead of in the sulphate of the peroxide of iron. According to his experiments, as detailed to the Academy of Sciences, the resulting battery is not only cheap, but effective. It is probable that zincate of ammonia and carbonate of zinc are formed during the action which takes place.

Photography under Water.—No place is now safe from the incursion of photographers. Who would suppose that they could carry on their operations under water? Yet such is now the case, as M. Bazin has proved. His photographic studio consists of a strong sheet-iron chest, perfectly water-tight, with water-tight windows, that are in the form of lenses. The electric light is used, and renders distinctly visible any objects lying at the bottom of the sea, so that they may be photographed, and thus their nature and position be accurately marked. M. Bazin has remained at depths of nearly three hundred feet for about ten minutes. This application of photography promises to facilitate the recovery of lost objects, and the raising of sunken ships, etc.

A New Petroleum Lamp.—A lamp has just been contrived by M. Leplay, of Paris, that promises to be a very interesting addition to man's appliances for purposes of domestic illumination. The lamp consists essentially of a hollow ball of brass, mounted upon a stem and stand. The ball is closed at the top by a closely-fitting plug. When this plug is removed, the opening is seen to lead into an interior cylinder, or space separated from the rest of the interior cavity by a roll of metallic gauze. Between the gauze cylinder, and the external wall, the lamp interior is packed with sponge. When the lamp is to be charged, a quantity of a light and cheap form of Benzule, distilled for the purpose, is poured into the space, and the superabundance, over and above what is sufficient to saturate the sponge, is poured back again from the lamp, and the plug is closed. The lamp is then ready for use. The interior space of the lamp is immediately filled with the elastic vapour of the Benzule, which pours out as a stream of inflammable gas when the plug is removed. When this stream is lit it continues to burn with a bright clear flame, until the sponge is exhausted by the process of spontaneous evaporation. About two-thirds of an ounce suffices to charge the sponge, and this charge enables the lamp to burn for about eight hours. This is the extraordinary part of the affair. The light of the flame is equal to something like that of two composite candles. The lamp may be turned over, and rolled about the floor upon its side, without in any way interfering with its burning, otherwise than by causing the flame to keep itself turned up at right angles to the vertical axis of the lamp. There is, of course, nothing to spill. If the lamp is turned upside down and jogged, while burning, it becomes apparent that the Benzule gas is heavy. The flame then drops from the lamp in successive sparkles. A considerable number of the lamps are to be immediately sent over to England for public sale.

MANGROVES.

Rhizophoraceæ.

[illegible]

[illegible] in a recent number [illegible] *Moraceæ*, it will be re[illegible] circumference of the plant [illegible] branches, which strike root upon meeting [illegible] the *Rhizophora*, another singular, though [illegible] occurs, and of that Mangrove [illegible] Most of our readers are aware of [illegible] plant; but some of them may, perhaps, [illegible]ately acquainted with it as to understand clearly [illegible] nor are they, perhaps, aware that there [illegible] species of *Rhizophora*, having the same [illegible] is associated in our minds with very [illegible] ideas of locality, [illegible] read of Mangrove swamps, and [illegible] or muddy shores, festering [illegible] much of its habit[illegible] little [illegible]

[illegible] distinct [illegible] to the [illegible] *Oleum*, [illegible] divided [illegible] *phyllæ*, [illegible] comprising [illegible] their [illegible] genera are *Rhizo-*[illegible]

[illegible] consists of trees or [illegible] leaves are oppo-[illegible] of the calyx [illegible] from the same [illegible] and [illegible] *ndela* [illegible] indefinite [illegible] superior [illegible] above the [illegible] calyx is persistent in several of the species.

[illegible] *Rhizophora* is distinguished from its allies by the calyx being divided into four parts, [illegible] four [illegible] [illegible], and the stamens which are [illegible] eight to twelve in number, having short filaments [illegible] with the pits,

THE MANGROVE AND ITS ALLIES.

BY JOHN R. JACKSON,

Curator of the Museum, Royal Gardens, Kew.

(*With a Tinted Plate.*)

THE peculiar manner of growth of the Banyan, and other allied species of *Ficus*, we noticed in a recent number of the INTELLECTUAL OBSERVER. In the *Moraceæ*, it will be recollected that the habit of increasing the circumference of the plants, is by the downward growing branches, which strike root upon meeting the ground. In the *Rhizophora*, another singular, though very distinct mode of growth occurs, and of this the Mangrove is a well-known example. Most of our readers are aware of the existence of such a plant; but some of them may, perhaps, not be so intimately acquainted with it as to understand clearly its mode of germination; nor are they, perhaps, aware that there is more than one species of *Rhizophora*, having the same peculiarity.

The name of Mangrove is associated in our minds with very unfavourable ideas of locality, we have read of Mangrove swamps, and we have notions of stagnant or muddy shores, fostering malaria or disease. We most of us know so much of its habitat; but we will endeavour to explain to our readers a little more about the Mangrove and its allies.

The genus *Rhizophora*, then, gives the title to a distinct natural order called *Rhizophoraceæ*, and placed according to the latest authority, Hooker and Bentham's *Genera Plantarum*, between *Halorageæ* and *Combretaceæ*. The order is divided into three tribes: *Rhizophoræ*, *Legnotidæ*, and *Anisophyllæ*, numbering in all seventeen genera, and the four comprising the tribe *Rhizophoræ*, have a similar habit of germinating their seeds before leaving the parent, these four genera are *Rhizophora*, *Ceriops*, *Kandelia*, and *Brugueira*.

The order is entirely a tropical one, and consists of trees or shrubs, mostly inhabiting the sea shore. The leaves are opposite, and the flowers usually axillary, the lobes of the calyx are valvate, not imbricate, the stamens arise from the same point as the petals, and are twice or three times their number, though in *Kandelia* they are indefinite. The ovary or fruit is sometimes superior, or seated above the calyx, as in *Rhizophora*, the calyx is persistent in several of the species.

The genus *Rhizophora* is distinguished from its allies, by the calyx being divided into four parts, the four petals sharply pointed, and the stamens which are from eight to twelve in number, having short filaments, and anthers with little pits,

containing the pollen. The ovary is partially adherent, and contains two cavities in the part where it so adheres, each of these cavities bearing two ovules; the free part tapers towards the top into a single style.

The Mangrove, *Rhizophora Mangle*, L., is an evergreen tree, rising some forty or fifty feet high, and presenting a very singular appearance, both as regards the appendages of its branches, and its peculiar manner of rooting. The following description of the Mangrove, is from a paper, read before the Pharmaceutical Society, by Dr. Hamilton, in June, 1846.—"The Mangrove is a tree frequently of imposing stature, attaining an altitude of from thirty to fifty feet or more, and occupying marshy situations, in the vicinity of the sea, as at the bottom of English Harbour, Antigua, and near the mouth of the little river which empties itself into the harbour, at Cape Henri, Hayti. Its roots rise in the form of arches, above the muddy soil in which it grows, and affords attachment to myriads of small but delicious oysters, which are left bare during the efflux of the tide, giving rise to the popular fable of oysters growing on trees, which, with the exception of their not being fed by, but merely adhering to the tree, is literally true. These oysters make a most incomparable soup, of which I once partook at the house of an American merchant, at Cape Henri.

"The shade of these trees affords harbour during the day to innumerable swarms of mosquitoes, which nestle on the under surface of the leaves, and infest the houses of those who have the misfortune to live in the vicinity of a Mangrove swamp during the night.

"But in the economy of nature, the Mangrove performs a most important part, wresting annually fresh portions of the land from the dominion of the ocean, and adding them to the domain of man; this is effected in a two-fold manner, by the progressive advance of the roots, and by the aerial germination of the seeds, which do not quit their lofty cradle, till they have assumed the form of actual trees, and drop into the water with their roots ready prepared to take possession of the mud in advance of their parent stems, and repel to a further and perpetually increasing distance the invasion of the water. The progression by means of the roots is effected by fresh roots, which issue from the trunks, at some distance above the surface of the water, and arching downwards, penetrate the mud, establishing themselves as the pioneers of fresh invasions of the retiring element. In this manner the plants soon after their descent from their parent trees, continue, during their early years, to advance steadily forward, till they have attained a height of about fifteen feet, and considerably in advance of

their parent trunks. After this, fewer additions are made to the roots, but the head begins to expand in every direction, spreading its branches on all sides; these branches in their turn, send down long slender roots, like those of the Banyan fig tree (*Ficus Indica*), which, rapidly elongating, descend from all varieties of height, and reaching the water, penetrate the mud, becoming in time independent trees; thus a complicated labyrinth of vegetation is at length formed, serving to arrest the particles of soil washed down from the interior; these, by their accumulations, raise the level of the ground, till at length what had been water, is converted into a salt marsh; and what had been a salt marsh, becomes progressively dry land, fit for the cultivation of man, and teeming with fertility from its copious intermixture with the exuviæ of marine animals and vegetables." The author of this description, compares the germination of the Mangrove to that of the Banyan, in "sending down long slender roots;" but it must be borne in mind, that these roots in the *Rhizophora*, are not spongioles, borne at the ends of the branches, but are the true radicles, and the only difference to the general law of vegetable life, is that they germinate before leaving their parents, so that the long stick-like protuberance from the fruit, is the young root, which reaches downwards towards the ground as far as possible, and when no longer able to hold on to the parent, drops into the mud below, and then sends out its rootlets; the rudiments of which are clearly distinguishable on the surface of the radicles, as they hang from the trees.

Dampier, in his voyages, says: "The Red Mangrove groweth commonly by the sea-side, or by rivers and creeks. It always grows out of many roots about the bigness of a man's leg, some bigger, some less, which, at about six, eight, or ten feet above the ground, join into one trunk or body that seems to be supported by so many artificial stakes. Where this sort of tree grows it is impossible to march by reason of these stakes, which grow so mixed one among another that I have, when forced to go through them, gone half a mile and never set my foot on the ground, stepping from root to root. The timber is hard, and good for many uses; the inside of the bark is red, and it is used for tanning of leather very much all over the West Indies."

In places where Mangroves abound, the propagation is effected by the simple and natural process of the germinating seeds dropping into the mud and immediately throwing out their rootlets. The fruit, before germination takes place, is described as being edible and of a sweet flavour, the juice of which is fermented and made into a kind of wine. The economic uses of the Mangrove are very many. A kind of

rough salt is extracted in Borneo from the aerial roots, and the wood is considered the best firewood of any produced in the island. The bark is well known as a tanning bark, for which purpose it is much valued; indeed, it has been said to equal, if not to excel, oak bark in the quantity of tannin which it contains. It is also used for dyeing, producing, in conjunction with mineral salts, olive, brown, and slate colours.

It is not the bark alone that contains tannin, but all parts of the plant. The leaves and roots of some of the species are used in the Mauritius and the West Indies for poultices; and in the last-named islands, as well as in the Phillipines, the bark is considered a good febrifuge. There are four or five species of *Rhizphora* known.

Ceriops stands next to *Rhizophora* in scientific classification. Two or three species are described, natives of Eastern Africa, Asia, Australia, and Polynesia. One of the distinctive characters of this genus is the five parted persistent calyx; the petals, also in fives, are pubescent or hairy at their points; and the ten stamens are seated two together in front of the petals. The bottom part of the ovary has three cells, each cell containing two ovules, the upper part of the ovary terminating in a long style, and the seed germinates before leaving the tree in a similar manner to that of *Rhizophora*.

Kandelia is a genus of which but one species is known, namely, *Kandelia Rheedii*, W. et A. It is a native of the East Indian Islands. The parts of the flowers of this, like the last-named genus, are in fives, but it is distinguished chiefly by the petals being divided and sub-divided into numerous fine divisions, and seated in a fleshy rim or disk, which lines the calyx tube. The stamens are indefinite, the filaments very fine, and the anthers small and oblong. The flowers are white and green; the fruit is ovoid, coriaceous, one-celled, and one-seeded, germinating on the trees as in *Rhizophora*. The bark of this tree, mixed with ginger or long pepper, and rose-water, is a reputed medicine among the native practitioners in India for the cure of diabetes.

Brugueira is a genus having six or eight species, natives of Eastern Africa, Australia, and the Polynesian Islands. They are trees frequenting the shores of rivers and muddy swamps, and are known from the preceding genera by the numerous lobes or limbs of the calyx, varying from eight to about fourteen, which adhere to the ovary below, thus making the calyx superior, or seated above the fruit, and standing up in a whorl round the radicle. From this arrangement of the sepals, the radicle might easily be mistaken for an elongated fruit. The petals agree in number with the sepals; they are coriaceous, and woolly at the edges, and cleft or divided in two parts.

The number of stamens are from sixteen to twenty-eight, and are placed as in *Kandelia,* in pairs, opposite the petals, and each petal is folded so as to form a hiding-place for the filament. The ovary has from two to four cells, each cell containing two ovules. The fruit being inferior, and the calyx persistent, it remains at the apex of the fruit; and when germination takes place, it is simply pushed away from the centre to make room for the young radicle. In this genus the roots are thrown up from below all round the root, as shown in plate.

The internal structure of the main root of the mangrove (*Rhizophora Mangle,* L.), as shown in a cross section, differs from that of the radicle. A good idea of the former may be had from Fig. 4, the outer and the central parts of which are masses of reddish brown fibrous tissue, while the ring is a very white, hard, woody substance, with clear and distinct rays crossing it in a direct line. A section of the radicle shows in the centre a mass of loose fibre surrounded by woody tissue, made up of silky fibrous bundles, the whole of a similar colour to the true root. The outer covering is composed of fine bundles of close, hard, woody fibre, arranged more or less regularly parallel.

The root of *Brugueira* shows in a cross section (Fig. 5) a similar arrangement to that of *Rhizophora,* except that the portion between the outer epidermis, or cuticle, and the ring of wood, is composed of thin paper-like divisions, regularly arranged, instead of an indiscriminate mass of fibrous tissue. These divisions, as will be seen by the figure, are very evenly placed, radiating from the centre. The appearance of one of these papery walls under the microscope is very singular and beautiful, presenting a mass of fine, glittering, scale-like markings.

DESCRIPTION OF THE PLATE.

Fig. 1.—Mangrove tree, *Rhizophora Mangle,* L. To the right is seen a tree of *Brugueira sp.,* showing its singular manner of throwing up its roots.

Fig. 2.—Germinating fruit and portion of the radicle of *Rhizophora Mangle,* L., showing the inferior calyx.

Fig. 3.—Germinating fruit and radicle of *Brugueira sp.,* showing the superior calyx. This is here represented as being reflexed, having been drawn from a dried specimen. It stands erect when fresh.

Fig. 4.—Cross section of root of mangrove, *Rhizophora Mangle.*

Fig. 5.—Cross section of root of *Brugueira sp.*

THE MAMMOTH AND ITS EPOCH.*

The discovery of the bodies of enormous animals akin to the elephant in the frozen soil of Siberia has excited the astonishment of naturalists and of the vulgar. The primitive nomads regarded them as monstrous burrowing rats, whose life was extinguished as soon as they saw the light of day; and the Chinese supposed that their subterranean movements gave rise to earthquakes. It has been generally supposed that Siberia had, in the mammoth days, a much warmer climate; M. de Middendorff disputes the conclusion, and states that the wood found in N. Siberia, and supposed to have grown there, is in reality drift-wood. It is also remarked, that the hypothesis of former heat in the Siberian climate would not solve the enigma, as it would not explain the good preservation in which the bodies of the great animals has been kept, which would seem only possible in a frozen soil, and the climate could not have changed so suddenly as to leave no time for their decomposition. Besides, the mammoths were well furnished with hair, and were not intended, like the modern elephants, to inhabit hot countries. Fir needles have been found between the teeth of rhinoceri, buried by the side of the mammoth, indicating that the latter may have lived in forests of conifers; but what was its food in the steppes which are beyond the limits of arborescent vegetation? M. de Middendorff supports the opinion that the bodies of the mammoths were drifted from more southern regions; but if this were the case, how is it that their bodies came to be so perfectly preserved in ice, and how was the congelation effected? Is it possible, as Adams thinks, that they found their sepulture in the midst of pure compact ice, and have been preserved there for millions of years?

On the recommendation of M. de Middendorff, the St. Petersburg Academy offered rewards of 100 to 150 roubles for the discovery of a complete mammoth skeleton, and of 300 roubles for that of a body with the soft parts entire. At Christmas, 1865, M. K. C. Von Baer received from Barnaul a notification that a Samoyede-Jurack had found an entire mammoth in 1864, with its skin, near the Bay of Tas, which opens into the Gulf of Obi.

This discovery, which was mentioned in former numbers of the Intellectual Observer, induced the Academy of St. Petersburg to send M. Frederic Schmidt to the spot. On the 24th March (last) he arrived at Yenissek, and from thence forwarded a piece of the mammoth's skin, which had been

* Abridged from an article in the *Archives des Sciences*, No. 108.

brought there by its discoverer. From Yenissek he was to travel, in the winter, to Ochotskoje ($70\frac{1}{4}$ N. L.), and to await for the disappearance of the snow for an opportunity of seeking for the mammoth. Pending his researches, MM. K. C. Von Baer and J. F. Brandt have published memoirs on the mammoth, from which the following information is taken :—

In the seventeenth century, Burgomaster Wilson, of Amsterdam, took great pains to collect information from Siberia, and he pointed out many localities in which mammoth tusks had been found, and added that certain animals had been seen, which were brown-coloured, and diffused a great stench.

In 1692, Ysbrandt Ides, sent overland as ambassador from Pekin to Peter the Great, reported that a man who collected mammoth ivory every year had found a mammoth's head sticking out of the ground, and had cut it off, and sent it to Turuchansk, together with a foot which he had also seen.

Messerschmidt found a skeleton which he thought complete, on the banks of the Tom.

In 1739—43, Chariton Laptew, who traversed the western coast of Siberia, reported that whole mammoths, with thick fur, were dug out of the banks of the Tundra.

In 1771, a rhinoceros, in a state of decomposition, was found on the banks of the Wiljui, and Pallas subsequently sent its head and foot (which had been brought to Irkutsk) to St. Petersburg.

In 1787, Lieut. Sarytschew heard at Alaseisk, on the river Alaseja, that the carcase of an animal as big as an elephant, covered with skin and with patches of long hair, had been found about 100 versts from that place, and about the same time a mammoth with skin and hair was found at the mouth of the Lena. Another mammoth with fur was seen on the shores of the Polar Sea; but the most celebrated discovery was that of Adams, the botanist, in 1806. This mammoth was near the mouth of the Lena. It had slipped down from a bank of sand, and was much torn by dogs and wild beasts.

The naturalist, M. Schrenk, in his journey through the country of the Samojedes, collected information concerning two skeletons found in the great peninsula between the Carienne Sea and the Gulf of Obi.

The Moscow skeleton, deficient in its posterior extremities, belonged to an animal discovered at Jenissei in 1839.

In 1843, M. de Middendorff found the remains of a mammoth in lat. 75°, near the Taimyr, fifty versts from the Polar Sea. The soft parts were decomposed, and the bones had lost their hardness.

Twenty years ago another mammoth was found in the

district of Yakustk, and to this the foot brought to Irkutsk, and seen by Leop. Schunk, is supposed to have belonged.

In 1860-62, M. Golubew reported the discovery of a great animal, with its skin, not far from the junction of the Wiljui with the Lena, and early in 1864 the mammoth already mentioned was seen.

M. K. E. von Baer remarks that the complete mammoth skeletons, with soft parts covering them, bear a small proportion to the quantity of mammoth remains found in a fragmentary state in northern Siberia. The flesh can only be preserved at a certain depth in a permanently frozen soil. The isolated bones and the complete skeletons represent much more than a single generation of the creature. Mammoth remains are scattered over Europe, though complete skeletons are rare, and Dr. Falconer found several species of fossil elephants in India. In Europe three species have been recognized, *Elephas primigenius*, *E. antiquus*, and *E. meridionalis*. Those of Italy appear to belong to the last species, as also do some of those found in the south of France. The northern regions of Siberia now furnish the most abundant remains; but as the southern parts have been long inhabited, it is possible that their inferiority in this respect has resulted from the quantities of tusks that have been removed by fossil ivory collectors, whose occupation is known to have been ancient. Certain isles of the Polar Sea now supply the greatest abundance, especially the Ljächow Isles, north of Swätoi-Noss, between the mouths of the Lena and the Indigirka, about 74° lat. The soil of the first of these islands is composed of fossil bones, which are loosened by storms and by the action of the sun. A group of large islands, not yet visited by a naturalist, and known as New Siberia, appear to contain an immense quantity of bones, accompanied by bitumenized tree trunks. Fossil ivory, weighing 20,000 lbs., was collected in the locality in 1821, notwithstanding a previous collection of 10,000 lbs, in 1809.

Extensive remains are also found at the mouth of the Chatanga, and the north-east angle of Siberia furnishes a large annual supply of tusks, contrary to what might be expected if the mammoths had drifted from the south. The two Anjui, affluents of the Kolyma, are also very rich in fossil bones, and it is the opinion of travellers and ivory hunters that the quantity of tusks increases as the districts are more north. M. de Middendorff estimates the quantity of fossil ivory annually obtained from N. Siberia at 40,000 lbs., and this is a low average, as he states 60,000 lbs. to have been the smallest quantity obtained between 1825 and 1831; and he mentions two years in which the quantity rose to 80,000 lbs. As in the extreme north the tusks are in general small, and do not exceed 120 lbs. in New

Siberia, we may assume that the quantity mentioned resulted from the spoils of at least 150 animals, or, making allowance for young ones and damaged specimens, 200 would be a probable supposition.

With respect to the date at which these creatures lived, M. de Middendorff observes that the Taimyr specimen was buried under a stratified mass of sand and clay thirty-five feet thick. He could not discover any trace of marine mollusks, but half way up the slope he found a layer of pulverized lignite, one inch thick, mixed with gravel, which indicated a prolonged action of a gentle water current, and was inconsistent with the supposition that the sandbank had been formed by a sudden catastrophe. The presence in the sand, below the mammoth remains, of large pebbles of different mineral characters, seemed to indicate that they had been brought from various localities by blocks of ice, which had deposited them in situations which larger blocks could not reach.

M. Von Baer states, that in the Tundra and on the banks of the Taimyr, he noticed that the mammoth remains were always in layers, above the beds composed of sand with pebbles, and he considered the mammoth layers as resulting from the erosive action of the sea on coasts recently emerged, and in process of elevation; and he found near the mammoths in some beds marine shells of species still living in the Polar Sea.

From these facts he concluded that the mammoth lived at an epoch when the climate was pretty much as it is now. Rejecting all ideas of sudden cataclysmal changes, he observed that, if at the eocene epoch the climate was tropical, and if during the formation of the upper miocene beds the majority of the tropical animals and vegetables still existed, and if at that time the mean temperature of the polar circle was many degrees higher than at present, the mammoths cannot be assigned to an earlier epoch than that of the transition between the pliocene and post-pliocene epochs.

M. Von Baer does not doubt that the mammoths were contemporaneous with man, and in addition to other evidence, some Chinese traditions point in this direction.

The most important question concerning mammoths is, whether or not they lived on the coasts of the Polar Sea, which are now destitute of forests, or whether their remains were carried from the north by rivers descending from the wooded country of Southern Siberia. M. de Middendorff adopts the latter hypothesis, and remarks that while it is not uncommon in Southern Siberia to find remains of animals which seem to have lived on the spot, and to have been engulphed in a standing position, the remains found in the

north are deposited on their sides. On the other hand, it is difficult to account for the transposition of the bodies of the mammoths, without injury, to great distances.

M. Brandt, adopting an intermediate view, says, "The numerous examples of mammoths found erect, combined with the idea that those which have preserved their skin and hair without injury could not have been carried along by water, induced me to communicate to M. Humboldt the opinion that the carcases in good preservation had been buried in an alluvial deposit (*vase*) in the locality in which they were found; that they had subsequently been covered by fresh layers of fluviatile deposit, and frozen in the autumn. A rigorous winter succeeding completed the process, and the frigid alluvium had preserved them against thaw from their time to ours." M. Brandt considers that the climate must have been warmer to have allowed the growth of sufficient vegetable food in Northern Siberia, but not temperate, or the mammoth carcases could not have remained frozen.

It is hoped that the researches of M. Schmidt will solve some of these doubts.

ARCHÆOLOGIA.

Mr. J. T. Blight, one of the most distinguished of the Cornish antiquaries of the present day, has recently communicated to the Penzance Natural History and Antiquarian Society the result of excavations in the Treveneage Cave, in the parish of St. Hilary, near Penzance. This cave consists of a series of subterranean chambers, which were first discovered, about twenty years ago, by the removal of some of the roofing stones in the course of agricultural labours. In the earlier part of last October, an attempt was made to resume these former explorations, and they were continued during the rest of the month with considerable success. They have, as far as now carried, brought to light a passage about forty-five feet long, four feet wide at the base, and three at the top, and four feet nine inches high. The whole is walled with dry masonry, the stones being carefully placed so as to receive the large slabs thrown across to form the roof, which is still perfect in the easternmost part to a length of twelve feet six inches. Within a foot of the extremity of this passage, a doorway, one foot six inches high by two feet four inches wide, the jambs and lintel of which are each formed of one stone, leads into a cell cut in the clay, with an arched roof, but without any coating of stones. It is of an elliptical form, fifteen feet long by six feet broad, and only four feet high. At right angles to this doorway, and at the end of the passage, is another door, about the same height, but only one foot three inches in breadth. This leads into a chamber which, when first opened, was found to be com-

pletely filled with clay and stones. This had been only imperfectly cleared out at the time when Mr. Blight made his report. At the beginning of the recent excavations, a part of some iron instrument, with a socket, was found about midway in the length of the great passage; and several other pieces of iron—some, it appears, with wood adhering to them, were found in different parts of the cave. Several pieces of worked bone were found, and two or three varieties of pottery, one of which had been an elegantly-shaped vessel of a very fine ware, glazed or enamelled within and without, and with a kind of zigzag ornamentation. This is pronounced by Mr. Blight to be undoubtedly Roman. At the bottom of the passage, for a length of twenty-six feet, the space now uncovered was found to contain a mass of burnt stones and other matter, with great quantities of charcoal, small pieces of bone, and fragments of pottery. This black layer was from eight inches to a foot in depth; and in the midst, adjoining the north wall, a curved bone, fifteen inches in length, and one and a half inches thick, was found, laying close behind a broader piece, six and a quarter inches long, which rested on pottery. There were within a radius of a few inches other pieces of pottery, but not enough to form a complete vessel, with charcoal, a lump of corroded iron, four inches long, and a portion of a large flint pebble. In this passage, also, was found a wrought stone, four inches square by three thick, resembling in form a modern building brick; and other stones, which seemed to have been used for sharpening tools, or for grinding, with a rude stone celt or hatchet. The floor of the elliptical chamber was also strewn with charcoal—some pieces so entire as to show the original size of the wood.

The mixture in this "cave" of objects apparently Roman with others of a ruder character, may perhaps indicate only that it was occupied in the Roman period by people who belonged to the older native population, of whatever race, and who were perhaps employed in the mining operations formerly carried on in this district. The presence of so much burnt materials may perhaps be partly explained by the circumstance, that the field in which the cave is found, which occupies high ground midway in the isthmus stretching from Hayle to Marazion, and commanding nearly the whole of the valley, with Tregoning, Castle-an-Dinas, and other hill-castles in view, is called the Beacon. Mr. Blight deserves great praise for the careful and intelligent manner in which he has carried on these excavations.

Much attention has been called of late to the SCULPTURED ROCKS, which are found especially in Northumberland and the eastern border of Scotland. We have before us a very valuable little book on these singular remains, by Mr. George Tate, of Alnwick, the author of a very excellent *History of Alnwick*, the first volume of which has been recently published. The book to which we allude is entitled *The Ancient British Sculptured Rocks of Northumberland and the Eastern Borders, with Notices of the Remains associated with these Sculptures.* Mr. Tate's very comprehensive essay contains carefully executed engravings of all the rock sculptures he has been able to trace through the district just mentioned. These sculp-

tures, as it is well known, consist chiefly of groups of concentric circles, with straight lines drawn from the centre to the exterior, and sometimes from the centre of one group to that of another group. Mr. Tate, whose essay we recommend to the attention of our readers, thinks that these sculptures date back as far as from 2500 to 3000 years ago, that they are the work of the primeval Celts, that they were made with stone implements, and that they have a symbolical meaning. Mr. Greenwell considers them to be undoubtedly religious. Mr. Tate quotes a writer in *Notes and Queries*, who says, that in a Welsh book, published in 1710, allusion is made to a custom formerly prevalent among shepherds in Wales, of cutting on the turf a labyrinthine form they called *Caer-Droida*—the walls of Troy—a practice supposed to commemorate the Trojan origin of the Welsh. A similar custom, Mr. Tate says, was continued even in a recent period, by the herdsmen on the grassy plains of Burgh and Rockliff Marshes, in Cumberland; but from the description of these figures, he conjectures that they were serpentine and spiral, like the sculptures at New Grange and in Brittany. We perfectly recollect the Troy town, as it was a common amusement to draw it on slates in our school-boy days, on the borders of Wales, but among the pure English stock on this side the border; and they certainly were not the spirals Mr. Tate supposes, but resembled rather closely some of these sculptures on the rocks. Moreover, we, as boys, had a very widely-prevailing practice of drawing groups of concentric circles, for a game, or rather a trick, which produced just such groups with lines from the centres, sometimes joining two centres, exactly in the same manner as these concentric circles represented on the rocks. We have seen the slate of a boy, who happened not to have at hand a sponge to rub out one group before he made another, covered with them, and presenting an exact counterpart of the groups of sculptures on the Northumbrian rocks. We confess that we feel some difficulty in accepting the extreme antiquity of these sculptures, and still more the notion of their being of a religious or symbolical character. We may add that Professor Simpson, of Edinburgh, has contributed to the new volume (vol. 5, new series) of the *Transactions of the Historic Society of Lancashire and Cheshire*, a short paper on sculpture of a similar character, found on the CALDER STONES, near Liverpool, in which he takes a similar view of their antiquity, but is unwilling to venture an opinion as to their purpose.

The same volume of the *Transactions of the Historic Society* contains a rather elaborate paper on the BONE CAVES OF CRAVEN, and their contents, by a well-known and meritorious antiquary, Mr. Ecroyd Smith. These caves, chiefly found at Settle and Arncliffe, contain human bones, with the bones of numerous animals, two or three of which belong to species now extinct in our island, and a considerable number of objects of human manufacture, such as coins, fibulæ, etc. By far the greater portion of these are undoubtedly Roman, and belong to a late period of the Roman occupation of our island, while the other objects are merely of ruder materials and ruder workmanship, and present no characteristics which

would fix their date independently of the other objects with which they are found. Under these circumstances, we think we are justified in considering that they also belonged to the Roman period, for there must have been a class of the population in a ruder state, and with ruder manufacture, than the high class of Romano-Britons. We hold still that the contents of these caves show that the period at which they were occupied by man was the close of our Roman period, when this country must have been in a state of great confusion, and life must have become almost savage. Perhaps the coins and the more ornamental objects of art may be the remains of plunder. Mr. Ecroyd Smith produces some examples of a class of round fibulæ, made of bronze, found in these caves, which he calls "ancient British brooches," and on the extreme antiquity of which he insists. We have always thought that the style of art of these fibulæ is in character debased Roman or Greek—a barbaric style, formed on Roman or Greek models—and it seems to us to belong rather to the very beginning of the middle ages than to the prehistoric period. But we would call Mr. Smith's attention to the fastening pins of these fibulæ, which are so minutely identical in character with the pins of the Roman fibulæ, that we think they are clearly either Roman or imitation of Roman. We cannot leave this volume of the Historic Society's transactions without saying that it contains some excellent papers, and that it is altogether highly creditable to the scientific body which has produced it.

The opinion of recent antiquaries, that Old Malton, in Yorkshire, occupies the site of the ROMAN TOWN OF DERVENTIO, seems to be fully confirmed by recent discoveries made at Norton, a parish separated from Old Malton by the river Derwent. These excavations have brought to light numerous objects of Roman manufacture which appear to show that a principal cemetery of the Roman town occupied this site. T. W.

LITERARY NOTICES.

THE GARDEN ORACLE AND FLORICULTURAL YEAR-BOOK, 1867. Edited by SHIRLEY HIBBERD, F.R.H.S., Author of "Rustic Adornments for Homes of Taste," "Brambles and Bay Leaves," "Essays on Things Homely and Beautiful," "The Town Garden," etc., etc., and Editor of the "Gardener's Magazine" and "Floral World." (Groombridge and Sons.)—This is a remarkably useful book, and from its very small price, no one with a piece of garden need be without it. It commences with a series of tables especially useful for gardening operations, such as seed-sowing, planting, draining, application of manure, the contents of vessels used in horticulture, etc., etc. Then we have an interleaved almanac, with notes on the cultivation of divers fruits, and the names of sorts best adapted to different situations. Then comes a "Calendar of Garden Work," followed by interesting and valuable notes on the "New Plants of

1866" (many of which seem well worth attention), "New Ferns," and "New Flowers," add to our information on these subjects; and the whole winds up with an interesting chapter on "Odds and Ends." Mr. Shirley Hibberd is unrivalled in labours of this kind.

An Essay on Dew, and several Appearances connected with it. By William Charles Wells. Edited, with Annotations, by L. P. Casella, F.R.A.S., and an Appendix by R. Strachan, F.M.S. (Longmans.)—Dr. Wells's Essay on Dew has acquired a fresh interest, not only from recent discoveries, but also from the reference made to it in a popular work of Professor Tyndall, and as the original editions have been long out of print and copies very scarce, M. Casella deserves the thanks of scientific students for having reprinted it in a handsome form, and with valuable additions. Dr. Wells's statement of his experiments, and his exposition of the views to which they led are remarkably interesting, and few scientific works will better repay perusal.

Animal Magnetism and Magnetic Lucid Somnambulism. With Observations and Illustrative Instances of Analogous Phenomena occurring spontaneously, and an Appendix of Corroborative and Correlative Observations and Facts. By Edwin Lee, M.D., Etc. (Longmans.)—This work is an epitome of stories and evidence pertaining to the so-called subject of "animal magnetism" and somnambulism. It is not what we should call a scientific work, as it does not exhibit the application of any powers of analysis, or of those prudent philosophic doubts with which phenomena should be scrutinized, and their interpretation attempted. That mesmerism and its associated subjects are really worth profound study we feel assured, but as a rule, these matters are neglected by good experimentalists and acute thinkers; and we have on the one hand a vast quantity of marvellous assertions resulting from credulity, and on the other a more comprehensive denial than an extended collocation of facts would warrant. As matters intimately connected with nervous physiology, we should gladly see the facts of mesmerism and spirit-rapping separated from the fancies, delusions, and frauds which constitute no small portion of the records with which the public have become familiar. We fear Dr. Lee will not effectually assist in such a movement as he seems to us prone to premature belief.

The Elements; an Investigation of the Forces which determine the Position and Movements of the Ocean and Atmosphere. By William Leighton Jordan. Vol. I. and II. (Longmans.)—The author believes in what he calls "astral gravitation," which he conceives to counteract the attraction of the sun and moon upon the waters of the globe and upon its atmosphere. To this "astral attraction" he ascribes the tides in parts of the earth opposite to the sun and moon. We do not understand the writer's line of argument. He talks of the action of gravitation as tending to convert the universe into a motionless mass, but a "force of evanescence" is brought into play, and saves it from such a result, and we are further told that "evanescence implies a motion of evanishing particles," and that contraction is a necessary consequence of it.

NOTES AND MEMORANDA.

FOOD OF THE HERON.—T. Y. Greet, Esq., of Morris Hall (near Edinburgh), writes: "On the 7th instant my keeper shot a young heron. To-day, on being prepared for table, it was found to contain two redwing thrushes and a water-wagtail; one of the former was in a most perfect condition, hardly a feather removed. Is such a thing usual in the heron's habit of feeding?" [In Morris's *British Birds* the heron is described as omnivorous, and, amongst other things, is said to eat the young of other birds. ED.]

GAUGING THE LIGHT OF SPOTS ON THE MOON, AND CHECKING ADDITIONS.—The Rev. N. J. Heineken writes: "It has occurred to me, in connection with the supposed altered brilliancy of the spot 'Linné' in the moon, that it might from time to time be tested by comparison with some other *fixed* place in the moon. This might possibly be done by a shade of thin metal over a portion of the diaphragm of the eye-piece, which shade should be pierced with a very fine hole, the light admitted through which could be at any period reduced to the same intensity as that exhibited by the spot under examination, by shades, or a wedge of ground glass, or other means. The comparison could thus be always made with ONE TEST spot. The plan in fact is not unlike the lamp micrometer of the elder Herschel. In a former letter I mentioned to you the application of Perkins's pedometer to the counting of meteors, and I have lately found it very useful as a check upon the tedious and often uncertain process of addition. For instance, in ascertaining the result of metorological observations, the string is pulled for each unit in a column, the tens carried to the next, the same written down and divided by the days as usual to obtain the means. This I have found a *complete* check upon previous *ordinary* addition. If the above suggestions appear of any value, pray make use of them as you think fit. The plan proposed for observations on the moon I have lately tried *myself* with a prospect of success."

MR. RUTHERFORD'S CELESTIAL PHOTOGRAPHY.—Dr. Gould, writing in *Astronomische Nachrichten*, states that Mr. Rutherford, with a photographic object-glass of 11½ inches aperture, has carried his process to such perfection that he readily obtains impressions of stars 8½ mag., provided they are not red. It is easy to obtain the image of a region one degree square.

AN ANGLE MEASURER, by Thomas D. Smeaton. In vol. viii., p. 197, our readers will find "A New Angle Measurer" described by N. J. Heineken. This paper attracted the attention of Mr. Thomas D. Smeaton, of Robe, South Australia, who proposes a modification, which he thinks an amateur might easily construct. He dispenses with the tube shown in Mr. Heineken's drawing, and makes the wheel of hard wood three inches in diameter and one inch thick. This is weighted by driving a bullet in a hole at the place where Mr. Heineken puts a weight, and an exact counterpoise is obtained by forcing shot into small holes at the back of the instrument. The wooden wheel has flanges quarter of an inch high, and in its concavity he fastens a slip of paper graduated from 0 to 90 upwards, and from 0 to 90 downwards, leaving a space between the zeros equal to the thickness of the suspending wire. "To use the instrument, hold it between the object and the eye, so as to make the wire cover the object; the wire will then cut the graduated flange at the angle of altitude, using the upper and lower edges of the wire for the corresponding gradients. Similarly the shadow of the wire will give the sun's altitude." Let us take this opportunity of thanking Mr. Smeaton for sending us some beautiful Australian compound polyps and polyzoa.

SIMULTANEOUS CONCEALMENT OF JUPITER'S SATELLITES.—The *Monthly Notices* contain an announcement by Mr. Airy of the approaching and rare phenomena of the simultaneous concealment of Jupiter's four satellites. He says, "On Aug. 21, Jupiter will be without satellites for one hour and three quarters." At 8h. 14m. the third satellite will enter on Jupiter's face; at 9h. 9m. the second will be eclipsed; 9h. 28m. the fourth will enter on Jupiter's face; 10h. 4m. the first will enter on Jupiter's face. Times of reappearance respectively 11h. 49m., 12h. 13m., 12h. 23m., 13h. 54m.

ACOUSTIC FIGURES.—*Cosmos* describes the following method adopted by M. Kundt. In a tube about a yard long and a third of an inch in diameter, pour a little lycopodium powder, and shake the tube so as to distribute it equally all

over its interior. Then make the tube vibrate longitudinally, which may be done by rubbing one end with a moist cloth, and the powder will unite at certain points, exhibiting the spiral nodes of Savart. If, after the lycopodium is applied, the tube is closed at both ends, and fixed by one or two bands (*nœuds*), the powder does not assemble at the spiral nodes, but assumes a peculiar arrangement at the bottom of the tube. Periodical accumulations are remarked, composed of a series of transverse layers, separated by vacant spaces. By filling the tube with different gases, the length of the waves exhibited by the lycopodium will be found to vary in proportion to the velocities with which they conduct sound.

PETROLEUM IN SICILY.—Seven springs are said to have been discovered in Sicily, which it is intended to work.

FRICTION OF CELESTIAL BODIES AND ETHER.—M. de Fonvielle has a curious paper in *Cosmos* on this subject. The atmospheres of rotating bodies like the sun or planets must exert a friction on the ether of those surrounding them. The friction of the sun's atmosphere against this ether he estimates at thirty times that of our earth, and says, "other things being equal, the bigger a celestial body, the more the temperature of its surface will be raised by friction against the matter in space, and the greater the probability that this matter will be the seat of energetic reactions and combinations with the rotating bodies' atmosphere."

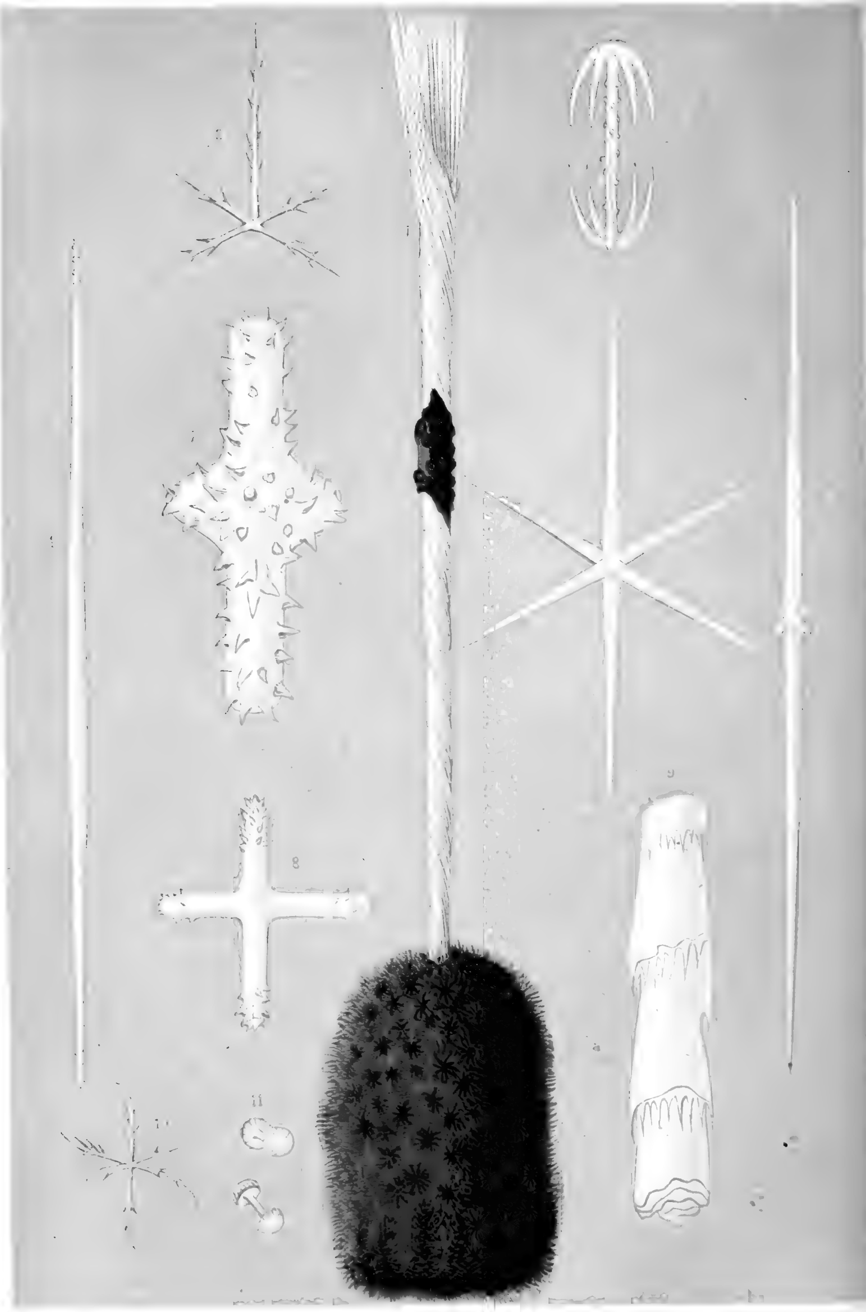
A SPONTANEOUS GENERATION EXPERIMENT.—M. Donné states, *Comptes Rendus* (Jan., 1867), that he makes a small hole in an egg with an awl, previously made red hot. He pours out about a third of the egg's contents, fills it up with boiling distilled water, closes the aperture with wax, and keeps the egg in his room at a temperature of 17° to 24° C. In five days he finds the egg-matter swarming with vibrions.

EYES OF CATERPILLARS.—M. Hermann Landois states that all kinds of caterpillars possess six eyes on each side of their heads, immediately below the articulation of the mandibles. The cornea he finds to be divided in three segments, each exhibiting its proper curvature. Below the chitinous stratum of each cornea he observes a sphereoidal chrystalline lens, formed of striated and uncleated fibres concentrically arranged, and below these lenses he notices a diaphragm or iris composed of about thirty-five contractile fibres, and below the iris what is known as a " crystalline body," which seems to consist of terminal optical fibres. He regards these caterpillar eyes as intermediate between simple, and compound facetted, eyes, and proposes to call them " compound ocelli."—*Zeitschrift fur Zoologie.—Archives des Sciences.*

MOLECULAR FORCE IN LIQUIDS.—M. G. Van des Mensbrugghe referring to some experiments of M. F. Plateau states that if a vessel, about ten centimetres wide, is three parts filled with water, held in front of an open window at least six metres from the ground, and suddenly acted upon by a lateral shock, the fluid in falling will form bubbles, the biggest of which are generally five or six centimetres in diameter. He tried various liquids : the bubbles of alcohol soon break, fatty oils do not, from their viscosity, give a thin sheet, and their bubbles are small. In other experiments he places a globule of mercury about half a millimetre in diameter on the blade of a knife, and gradually, by immersing the knife, brings the mercury in contact with the surface of the water, on which it will float and exhibit the phepomena of capillarity. The depression of the concave meniscus is found to be very large in proportion to the size of the globule. The attraction of floating bodies for each other may be shown by floating several of these mercury globules.—*Pagg. Ann. Archives des Sciences.*

THE PLANET MARS.—The remarks in the fourth paragraph of my paper on Mars apply to Figs. 1 and 2, as originally drawn. The artist having reduced the scale by one-half, *one-sixteenth* of an inch corresponds to 4,000,000 miles. The reduction has been faithfully effected, save that, in Fig. 2, the short lines surmounted by arrow-heads have been left unreduced. I need scarcely say that I should have thrown the two figures into one, had I adopted the reduced scale. In the smaller globe of Fig. 3, the lower cusp of the shaded part should fall as much to the right of the line $m\,m'$ as the upper cusp falls to the left. It will be seen that the curve of the inner boundary would bring the cusp to the place mentioned, but that this curve has been slightly deviated from, close to the lower cusp.

R. A. PROCTOR.



HYALONEMA SIEBOLDI.

Fig. 1. [illegible] natural size.
Figs. 2, 3, 4, 8, about [illegible] diameters.
Figs. [illegible] 11 [illegible] diameters.
Figs. [illegible] 9, about [illegible] diameters.

THE INTELLECTUAL OBSERVER.

MARCH, 1867.

ON THE "GLASS-ROPE" HYALONEMA.

BY WYVILLE THOMSON.

(With a Coloured Plate.)

A BUNDLE of ... to 300 threads of transparent silica, glistening with a ... lustre, like the most brilliant spun glass; each thread about 18 inches long; in the middle the thickness of a knitting needle, and gradually tapering towards either end to a fine point; the whole bundle coiled like a strand of rope into a lengthened spiral, the threads of the middle and lower portions remaining compactly coiled by a permanent twist of the individual threads; the upper portions of the coil frayed out ... the glassy threads stand separate from one another ... of a glittering brush; the lower ... perpendicularly in the middle of ... sponge, and ... of the mucous coil and part of ... brown leathery coating, ... [illegible] ... specimen of ... first brought ... naturalist and traveller ... more or less perfect, ... brought home, it ... had been seen ... as to its ... distinct ... of silica ... had ev... served ... the finely brush ... spreading out above it in the water; and, thirdly, the apparently constant ... This complicated association suggested a multitude of speculations. Was Hyalonema a natural

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When the first specimen of *Hyalonema* was brought home, it stood in this peculiar position, that nothing had been seen in the least like it before, and the history of opinion as to its relations is curious. The being consisted of three very distinct parts:—first, and infinitely most remarkable, the twist of silicious needles; then the sponge, whose lower surface had evidently been attached to some foreign body, and which served as a sort of pedestal, from the top of which the flinty brush projected, spreading out above it in the water; and, thirdly, the apparently constant zoophyte. This complicated association suggested a multitude of possibilities. Was *Hyalonema* a natural

organism at all? Was it complete? Were the three parts essentially connected together? and, if not, were all the three parts independent? or, were two of these parts the same thing? and, if so, which two?

As my present object is merely to give a general sketch of the various attempts which have been made to solve this riddle, and to indicate the doubts and difficulties which still hinder its solution, while endeavouring, of course, to establish a harmony of opinion with my reader, I will trouble him as little as possible with technical details; nor do I feel called upon to work out the bibliography of the subject further than is necessary for my special purpose.

Hyalonema was first described and named in 1835, by Dr. J. E. Gray, who has since in one or two notices in the *Annals of Natural History*, and elsewhere, vigorously defended the essential points of his original position. Dr. Gray associated the silicious whisp with the zoophyte, and regarded the sponge as a separate organism. He looked upon the silicious coil as the representative of the horny axis of the sea-fans (*Gorgoniæ*), with which it certainly presented many analogies in minute structure, and the leather-like coat he regarded as its fleshy rind. He supposed, that between this zoophyte thus constituted, and the sponge at its base, there subsisted a relation of guest and host, the zoophyte being constantly parasitic in the sponge; and in accordance with this view he distinguished for the reception of the zoophyte, a new group of Alcyonarians, under the name of *Spongicolæ*, as distinguished from the *Sabulicolæ* (*Pennatulæ*) and the *Rupicolæ* (*Gorgoniæ*).

Dr. Gray's view seemed in many respects a natural one, and it was adopted, in the main, by Dr. Brandt of St. Petersburg; who in 1859, published a long memoir describing a number of specimens brought from Japan to Russia. Dr. Brandt illustrates fully the structure of this zoophyte, and refers it to a special group of sclerobasic zoantharians with a silicious axis.

In October last Dr. Gray published in the *Annals and Magazine of Natural History* an additional note on the "glass-rope" *Hyalonema*. While acknowledging his error in having referred the polyp incrusting *Hyalonema* to the barked Alcyonarians, an error of little moment if we admit the close relation of *Antipathes* to the typical zoantharia, the author adheres resolutely to his original view, and imagines that it has received full confirmation from the observations, hereafter to be noticed, of Senhor de Bocage; and in a short communication to the *Annals* for December, Dr. Gray alludes to a statement (which I can confirm) that the sclerobase of some *Gorgoniæ* contains silica. I will not at presen dwell farther upon these papers,

as most of the points upon which Dr. Gray relies for the defence of his opinion are more or less fully discussed in these pages.

One consideration militated strongly against the hypothesis of Gray and Brandt. No known cœlenterate zoophyte had a purely silicious axis; and such an axis, made up of loose separate spicules, seemed strangely inconsistent with the harmony of the class. Silicious spicules of all forms and sizes, were conceivable in sponges; and in 1857, Milne Edwards, on the authority of Valenciennes, who was thoroughly versed in the structure of the *Gorgoniæ*, combined the sponge and the silicious rope into a single organism, and degraded the zoophyte to the rank of an incrusting parasite.

Anything very strange coming from Japan, is to be regarded with considerable distrust. The Japanese are wonderfully ingenious, and one favourite aim of their misdirected industry, is the fabrication of all kinds of impossible monsters, by the curious combination of parts of different animals. It was therefore quite conceivable that the whole thing was an imposition; that some beautiful spicules separated from some unknown organism, had been twisted into a whisp by the Japanese, and then manipulated so as to have their fibres naturally bound together by the sponges and zoophytes, which are, doubtless, rapidly developed in the Mongolian rock-pools. Ehrenberg, when he examined *Hyalonema*, took this view. He at once recognized the silicious threads as the spicules of a sponge, quite independent of the zoophyte with which they were encrusted; but he suggested that they might have been artificially combined into the spiral coil, and placed under artificial circumstances favourable to the growth of a sponge of a different species round their base.

The condition in which many specimens reach Europe is certainly calculated to throw some doubt on their genuineness. It seems that the bundles of spicules, made up in various ways, are largely sold as ornaments, in China and Japan. The coils of spicules are often stuck upright, with their lower ends in circular holes in stones. Mr. Huxley exhibited lately to the Linnæan Society a beautiful specimen of this kind, now in the British Museum—a stone has been bored, probably by a colony of boring Mollusks, and a whole family of Hyalonemas, old and young, are apparently growing out of the burrows; the larger individuals more than a foot in length, and the young ones down to an inch or so, like tiny camel's hair pencils. All these are incrusted by the usual zoophyte, which also extends here and there over the stone (glued on probably); but there is no trace of the sponge. Such an association, as we shall see hereafter, is undoubtedly artificial.

Professor Max Schultze, examined with great care several

perfect and imperfect specimens of *Hyalonema,* in the Museum of Leyden, and in 1860, published an elaborate description of its structure. I can entertain no doubt of the soundness of Professor Schultze's conclusions. The present sketch has been chiefly abstracted from his memoir, though I may add that I have lately had an opportunity of verifying his observations in almost every detail. The conical sponge, which forms the base of the fabric, I believe to be the body-mass of *Hyalonema Sieboldi,* a sponge allied to the genus *Alcyoncellum,* Quoi and Gaimard (*Euplectella,* Owen); and the silicious coil to be an appendage of the sponge, formed of modified spicules, and recalling in some respects the fringe of long calcareous styles surrounding the osculum in our common little *Sycon ciliatum.* The zoophyte is of course a distinct animal altogether, whose only connection with the sponge is that it is apparently almost constantly parasitical upon it. This style of association is not at all uncommon; take for example *Pagurus Prideauxii* and its attendant *Adamsia,* and especially *Palythoa axinellæ* (Schmidt), a constant parasite upon *Axinella cinnamomea,* and *A. verrucosa,* two Adriatic sponges.

On looking over Dr. Bowerbank's papers on sponges in the *Philosophical Transactions,* I at first took for granted that he adopted the views of Valenciennes and Schultze. In an answer which he published in the *Annals and Magazine of Natural History* for November last to Dr. Gray's paper, he, however, distinctly states that he has "always maintained that the silicious axis, its envelopment, and the basal sponge were all parts of the same animal." The polyps he regards as "oscula," forming with the coil a "columnar cloacal system." This view, I confess, I do not fully understand. At all events, Dr. Bowerbank thinks that the so-called "polypigerous crust" is a part of a sponge. That this position seems to me to be utterly untenable, my description of the *Palythoa* will sufficiently show.

In 1864, Senhor J. V. Barboza de Bocage, director of the Museum of Natural History of Lisbon, communicated to the Zoological Society of London the interesting intelligence that a species of *Hyalonema* had been discovered on the coast of Portugal, and in 1865 he published, in the proceedings of the same society, an additional note "on the habitat of *Hyalonema Lusitanicum.*" It appears that the fishermen of Setubal, on the Portuguese coast, frequently bring up on their lines, from a considerable depth, coils of silicious threads, closely resembling those of the Japanese species, which they even surpass in size, sometimes attaining a length of about two feet. The fishermen seem to be very familiar with them. They call them "sea-whips," but, with the characteristic superstition of their

class, they regard all these extraneous organisms as "unlucky," and usually tear them to pieces, and throw them into the water. Senhor de Bocage has, however, succeeded in procuring several specimens, and one of these he has sent to the British Museum. This specimen I had an opportunity of examining, through the kindness of Dr. Gray. Judging from it and from Senhor de Bocage's figure, the "glass-rope" of the Portuguese form is not so thick as that of *H. Sieboldi.* I think there is some slight difference in the sculpture of the long needles, but I have not had an opportunity of making a minute microscopic examination of these. The thin (lower) end of the coil is entirely covered by the investing zoophyte, which extends uniformly over about two-fifths of the whole length. The polyps are oval, they project but slightly from the general surface, and are arranged regularly in spiral lines like the scars on the stem of a tree-fern. According to Senhor de Bocage, the granular appearance of the surface of the crust is not produced, as in the Japanese species, by agglutinated grains of sand, but by "an infinite number of club-shaped spicules bristling with points;" and, according to the same authority, "each polyp is supported by a silicious framework of filiform spicules, disposed longitudinally and at equal intervals on the internal wall of the body cavity." This latter point of structure is altogether peculiar, but in these and in other details *H. Lusitanicum* stands in need of the minute and careful study and illustration which it will doubtless receive from its discoverer.

Senhor de Bocage most accurately describes the mouth of the polyp as surrounded by a crown of not less than sixty minute, triangular, compressed tentacles, and justly suspects that the supposed difference in the number of tentacles between the Portuguese form and that described by Brandt might arise from an error of observation, depending, possibly, upon the bad condition of the specimens examined by the Russian naturalist. Although dead and somewhat dried up, in the specimens as procured by Senhor de Bocage the zoophyte was still soft, it had a strong fishy smell, and appeared to have been fresh when taken from the sea. No sponge-body has as yet been found in connection with any of the Portuguese specimens.

With regard to the essential nature of the organism, Senhor de Bocage leans to the view advocated by Gray and Brandt. He believes that as recovered from the deep by the Setubal fishermen it is homogeneous and complete. I have no hesitation whatever in expressing a most decided opinion that in this—as, indeed, in all such cases—the zoophyte is a parasite investing a coil of spicules which formed originally an

appendage of a sponge. The discovery at Setubal proves the interesting fact that a species of *Hyalonema* lives somewhere on the Portuguese coast, or, at all events, in the course of some one of the strong currents which wash the Lusitanic peninsula. The coil is hard, elastic, and insoluble—nearly indestructible. I believe that during the life of the sponge the *Palythoa* attaches itself to that portion of the coil just above the sponge body, and that after the disintegration of the sponge it creeps downward, naturally spreading towards that end of the coil where the spicules remain in contact.

The very fact that in *all* the Portuguese specimens the whole of the thin end of the coil is invested by the zoophyte, would suggest to me that the immediate neighbourhood of the coast of Portugal may not be the habitat of the *Hyalonema*, but that the isolated coils may have been gently drifted along the surface of the mud from a distance, and during a considerable space of time.

Hyalonema seems to be generally distributed. Dr. Leidy states that there is a small specimen in the museum of the Academy of Sciences at Philadelphia, said to have come from Santa Cruz.

I will now describe, a little more in detail, the structure and arrangement of the different parts of this singular sponge. The large silicious spicules form, as I have already mentioned, a brilliant coil, in large specimens upwards of a foot and a half long. The spicules on the outside of the coil stretch its entire length, each taking about two and a half turns of the spiral. One of these long needles is about one-third of a line in diameter in the centre, gradually tapering towards either end. The spirally twisted portion of the needle occupies rather more than the middle half of its entire length. In the lower portion of the coil, which is imbedded in the sponge, the spicule becomes straight, and tapers down to an extreme tenuity, ultimately becoming so fine that it is scarcely possible to trace it to its termination. Above, where the coil opens out, the spicule likewise becomes straight and tapers, but in all the specimens which have been examined the upper ends of the spicules have been broken off. The surface of the middle and lower portions of the spicule is perfectly smooth, but the upper part, where the coil is frayed out, has a frosted look, and feels rough to a finger drawn along it upwards. This roughness depends upon a series of little crest-like elevations, armed with minute teeth, which stretch about half way round the needle on alternate sides, at short intervals; or sometimes two of the crests unite into an irregular spiral ridge (Plate, Fig. 1).

Under the microscope, by transmitted light, the spiculum

throughout its entire length is minutely and delicately striated. These striæ are not superficial, they indicate the edges of, or the intervals between, a series of extremely thin concentric silicious layers of which the wall of the spicule is composed. A distinct double line running down the centre marks the central canal, so characteristic of all sponge spicules. A transverse section, or an irregular fracture, shows distinctly the concentric silicious layers (Plate, Fig. 9). One point in connection with the central canal is important as establishing a relation between the spicules of the coil and those of the sponge-body. About the middle of the spicule, at its thickest part, the canal sends out two transverse branches, or sometimes four in the shape of a cross. These branches are extremely short, only displacing slightly a few of the inner silicious layers; the outer layers gradually resume their straight course, so that no bulging or distortion is to be seen on the surface of the thread, and the point, where the branching occurs, can only be discovered with difficulty by transmitted light, and with a magnifying power of 300 diameters. When the sponge is fresh, the spicules of the coil are covered from end to end with an organic film, and there are likewise films of sarcodic matter between the silicious layers. This can be shown by heating the spicule over a lamp, when the organic matter shows out brown by the separation of free carbon. The spicules are stiff, but somewhat elastic. When forcibly bent, and then freed, they instantly resume the spiral curve which was stamped upon them during their growth. The spicules on the outside of the coil are all of the same size and length, but in the interior they are shorter and finer, diminishing to an inch or so in length and to a hair-like fineness, so that new spicules are added to the coil from within.

In good-sized specimens the sponge-body is from five to six inches high, and about three inches in its widest diameter. The surface is shaggy with the ends of irregular bundles of spicules, and is closely dotted over with small round openings about a line across. Round each of these apertures there is a stellate arrangement of ridges, the ridges round one opening running into those round the opening next it, so as to cover the whole surface of the sponge with an irregular raised network. In the dried specimens from which, as yet, all our information is derived, these ridges, and indeed the whole substance of the sponge, consists simply of interwoven silicious spicules of various forms, with a mere trace of organic matter between them, cementing them loosely together. In most sponges with silicious spicules, the skeleton is partly made up of membranes, or threads, or granular masses of a horny substance. A net-work of horny fibres is the most common form,

and usually the spicules are scattered loosely among the threads, though in some cases the spicules are contained within the threads ranged along their centre. In all these cases the sarcodic living matter coats and surrounds both the threads and spicules. In some silicious sponges, however, the horny substance, in its firm condition, is entirely wanting, and the skeleton seems to be made up of silicious needles alone, with incrusting soft incoherent protoplasm. *Hyalonema* seems to be nearly in the latter condition, for a structureless film only, easily soluble in caustic potash or soda, coats and connects the spicules of which its framework is built up. The interior of the sponge is formed of a loose irregular network of threads of interwoven needles. Towards the base of the sponge there are several large irregular openings nearly half an inch wide, leading into passages lined by an open imperfect membrane of meshed spicules. Within the sponge these passages divide and pass into connection with a sort of lacunar system, which communicates with the round apertures opening externally on the surface of the sponge.

The lower end of the silicious coil penetrates the sponge vertically nearly to its base. After entering the sponge it becomes slightly thicker for an inch or so, and then rapidly diminishes to an extremely fine produced point. The needles of the coil are here intimately interwoven with the ordinary spicules of the sponge which pass in among them. The cord-like fibres of the sponge-mass flatten out as they approach the coil, and the so-formed irregular plates are felted as it were into the coil vertically between and upon its outer needles, so that the arrangement of the tissue of the sponge bears an evident relation to the position of the silicious axis.

The connection between the body of the sponge and the lower end of the coil is so close that considerable violence is necessary to separate them; indeed, it is absolutely impossible to do so completely without injuring the infinitely delicate ends of the long needles. This circumstance alone, although it may not be conclusive against the parasitical nature of the sponge, entirely disproves the artificial arrangement of the needles of the coil.

The form of the silicious spicules which build up the tissues of the body of the sponge is most varied. Most abundant, interlaced to form the great bulk of the threads of the spongy texture, and accumulated especially towards the surface, are long spindle-shaped needles about a line in length. These spicules (Plate, Figs. 4 and 5) are frequently smooth, and pointed at both ends; but sometimes one end is pointed and the other clubbed, and very frequently either one end or both ends, or the whole length of the needle, is studded with short

pointed projections, usually turned towards the point of the needle, rarely bent backwards like barbs from either end towards the centre. In all these awl-shaped spicules a delicate central canal is very apparent, and, in all of them, at or near the middle of their length, one or two fine cross canals cut the central canal at right angles, exactly as in the long needles of the coil. When the cross canals have an appreciable length, two or four slight bulgings on the outer surface of the needle indicate their position (Plate, Fig. 5).

From this form we pass by an easy transition to a second class of very generally distributed spicules. In cases where a single cross canal only is developed, this canal has become produced into two arms at right angles to the original spicule, and the primary and secondary branches together form a cross (Plate, Fig. 8). When two transverse canals are produced, a star of four secondary branches cross the main shaft, giving origin to the remarkable six-spoked forms (Plate, Fig. 6). The larger of this group are usually nearly smooth, but very minute spicules of the same type, with all the branches feathered and their ends curved (Plate, Fig. 10), are very common, clustering in groups round the larger styles. Frequently one of the halves of the needle is undeveloped, and a form is produced in which the single long shaft, representing one half of the original spicule, stands out from a whorl of four transverse branches; all the rays are feathered. Such spicules line in large numbers the internal cavities and passages of the sponge. The cross is placed against the bounding felt of spicules, and the long barbed ray projects into the space, apparently to prevent the entrance of foreign matters (Plate, Fig. 2).

The most remarkable spicules are the two forms represented in Plate, Figs. 3 and 11. The larger of these (Plate, Fig. 3) consist of a strong shaft roughly tuberculated, with a well-marked central canal showing the characteristic cross processes. From either end of the shaft from seven to nine long teeth curve gracefully backwards, ending nearly opposite the centre of the shaft in fine points. These singular spicules are most abundant in the cortical layer, though they are found likewise scattered irregularly through the substance of the sponge. The other set (Plate, Fig. 11) are exceedingly minute, only to be detected by a power of about 300 diameters; they resemble those just described in general form, but the recurved hooks are united by a kind of silicious web, beyond which the point of the hooks project slightly, so that the expanded ends of these spicules are singularly like umbrellas. They resemble most remarkably in form and size the "amphidisci" of the gemmules of *Spongilla*; they are not,

however, found in connection, but are scattered along with the small cross spicules (Fig. 10) in great numbers throughout the whole of the sponge substance. Many spicules of the awl-shaped and simple cross types, especially short spicules, represented in Fig. 7, are met with within the silicious coil to its very centre, and, in cases where the coil has been brought home without the sponge, such needles can be shaken out from the interstices of the threads. The spicules of *Hyalonema* are marked in their character, and all the forms described above are found in all specimens of the sponge imbedding the characteristic bundle of enormous spicules; so that there can be no reasonable doubt of the specific identity of the sponge in all cases.

Within the round apertures on the surface of the sponge there is usually a brownish orange-coloured membrane. At first sight one would never dream of doubting that this membrane forms part of the sponge, but, on examining it with a high power in order to make out its minute structure, Professor Schultze found, to his surprise, that it presented the marked characters of a polyp tissue; in fact, that it was the remains of a minute parasitic polyp, probably alcyonarian, which inhabited the oscula and their passages during the life of the sponge. The thread cells of the polyp membrane are quite distinct, and it has even been possible to isolate entire extremely minute fringed tentacles, richly clad with almost linear thread-cells.

The view adopted by Gray and Brandt, that the silicious coil is the axis of a zoantharian zoophyte allied to the *Antipathes*, is founded upon the circumstance that the coil of silicious spicules is almost always coated to a greater or less extent, by a dark leathery layer, studded with the projecting bodies of true polyps. The outer surface of the investing layer is rough with included particles of sand, shells of foraminifera, and sponge spicules, chiefly those of *Hyalonema*, and these spicules usually become very numerous in the polyp layer in the immediate neighbourhood of the body of the sponge. Beneath this layer, with its contained foreign bodies, there is a thick band of a nearly transparent matrix, with scattered, oval, yellowish, granular masses. Within these ovals are imbedded very characteristic groups of thread-cells, oval, half filled with granules, and half with a delicate, spirally-coiled thread. Such thread-cells are generally distributed throughout the cœnosarc, and in the walls of the polyp bodies. A third, loosely-areolated, thin layer grasps closely the surface of the silicious threads. Some doubt arose at first whether this third layer belonged to the zoophyte or to the sponge. It most likely forms the basement membrane of the cœnosarc of the

former, as a still thinner membrane, with a somewhat stellate arrangement of its substance, can sometimes be detected beneath it, and spreading along the large spicule beyond the portion incrusted by the zoophyte. This, the most delicate of all the investments, very probably consists of a dried-up layer of sarcodic sponge matter.

I have lately dissected carefully the species or variety of *Palythoa,* which gives its peculiar character to Brandt's *Hyalochæta Possieti.* In this species the projecting polyps are cylindrical, and in some cases about a line in length. In their retracted state, they show a small round opening in the centre of a mammillary projection, the opening surrounded by about twenty obscure radiating lines. When softened by being steeped in dilute acetic acid the polyps become quite plump, and are almost as easily examined as if they were fresh. The external body-wall consists as usual of two layers, of which the outer is thickly coated with imbedded grains of sand. In the specimen I last examined, I could not detect in this layer a single characteristic spicule of *Hyalonema;* fragments only of linear needles were mixed here and there with the sand. In other specimens, however, I have found the surface crowded with *Hyalonema* spicules; but I am confident that in these cases they were embedded simply as grains of sand, or any other foreign bodies might have been. The peristomial space contains a crown of at least sixty tentacles, in three alternating rows, those of the outer row the larger. The tentacles are short and conical, with the peculiar curve which is characteristic of *Zoanthus* and its allies; rather large oval thread cells are scattered sparingly in their walls.* The digestive sac is fluted and corrugated, and its upper portion only is attached to the body wall by about twenty membranous mesenteries. There is no trace of spicules, either silicious or calcareous, in the inner layer of the body wall, in the wall of the stomach, or in the mesenteries.

There seems to me to be no character whatever to separate this zoophyte from the well-known zoantharian genus *Palythoa,* to which, following Professor Schultze, I have already referred it. I have not yet had time to examine many specimens with due care, but my present impression is that we are acquainted with three species of *Palythoa* incrusting the coils of two species of *Hyalonema* — 1. the *Palythoa* with round, depressed, irregularly-arranged polyps, parasitical upon most of the specimens of *Hyalonema Sieboldi* from Japan;

* The crenated tentacle figured by Schultze (Taf. 5, Fig. 4) is not that of *Palythoa,* as stated by Dr. Gray (*Ann. and Mag., Nat. Hist.*, Oct. 1866), but is a tentacle of the minute Alcyonarian parasite, which Professor Schultze detected within the pores and passages of the sponge.

2, the form with produced polyps, investing the same species, and distinguishing *Hyalochæta Possieti* of Brandt; and, 3, the species with oval polyps more regularly arranged, which seems to be constantly associated with *Hyalonema Lusitanicum.*

Such is an outline of the structure of *Hyalonema,* so far as it can be made out from dried specimens. After the careful microscopic observations of Schultze, I think there can be no doubt whatever that the silicious coil and the sponge form one organism. Perhaps the most conclusive proof of this is the essential correspondence in structure and plan of growth between the long spicules of the coil and the spicules of the body of the sponge; and the peculiarity of that mode of growth distinguishes *Hyalonema* from most other sponges. Since Professor Schultze's memoir was written, many additional specimens have been brought to Europe. All of these, so far as I know, are in the same dried and partially mutilated state. I saw, I should think, nearly a hundred in London last year. Most of them had lost all traces of the sponge, and almost all were coated through the greater part of their length with *Palythoa.* The zoophyte was often continued quite down to the lower end of the coil, which in all these cases was more or less truncated and injured. Many of the specimens had the egg-bags of a small shark or dog-fish attached to them. From the appearance of all I have little doubt that the coils had first of all got disengaged from their investing sponges by the decay of the sponges or by a storm, and that afterwards the *Palythoa,* and other animals and plants, attached themselves to the free coils lying between the rock-pools or between tide-marks.

The two specimens figured in the woodcuts are among those in the Museum of Queen's College, Belfast. In one of these (Fig. 1) the thin end of the coil is entirely coated with the incrusting zoophyte. The polyps stand out considerably from the general surface of the crust, and here and there the cænosarc and the polyps run together into irregular, projecting, knob-like masses. This specimen must clearly be referred to the form named by Brandt *Hyalochæta Possicti,* indeed, it closely resembles the specimen from which Brandt's figure was taken. One of the terminal polyps has been broken off, and the truncated, somewhat worn end of the coil has been thus exposed. As the thin end of the coil is always uncovered by the zoophyte when it is inserted into and connected with the sponge, and as the coil could not possibly have been poised in the sponge without any attachment, and in its present condition, it is evident that in this case the "polypigerous crust" must have been extended over the end of the coil after

the latter had become separated from the sponge. Admitting this, the zoophyte must have grown over the lower end of the coil as it might have grown over any other foreign body, and this appears to me to be totally inconsistent with the idea that the coil was originally secreted as an axis by the same animal.

In the other specimen (Fig. 2), both ends of the coil have been frayed out, probably by long drifting in shallow water. The *Palythoa* occupies the central portion, and in extending in both directions it has coated several of the individual spicules. Some of these are uniformly incrusted by the arenaceous layer, the polyps standing out at intervals. This can be explained by no mode of branching of which we have any experience. In *Gorgonia* or *Antipathes*, as in most other branching organisms, a young branch is a repetition of the early development of the stem from which it springs. A branch of *Hyalonema*, were this an animal or a colony capable of branching, would undoubtedly contain as its axis a fascicle of growing needles.

A week or two ago, Dr. Gray received at the British Museum two specimens of the Japan *Hyalonema*, which appear to me to be highly instructive.

I was in the Museum when they arrived, and Dr. Gray, with characteristic generosity, placed them at my disposal for examination, before he had even had time to look at them carefully himself. In one of these the basal sponges was uninjured. No trace whatever of the *Palythoa* was to be seen on the coil.

It is well known that the Japanese often strip off the crust to improve the appearance of their specimens. There are few things more fragile or more offensive than a loosely meshed silicious

Fig. 1.

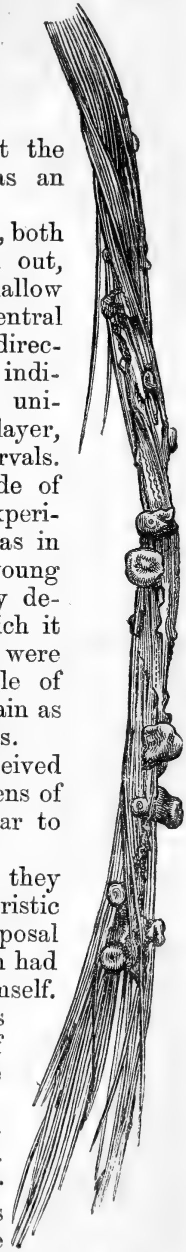


Fig. 2.

sponge in its fresh state, and it is very unlikely that where the bark was so thoroughly removed, the sponge should have been saved. In the other specimen the sponge was wanting, but the lower part of the rope was well coated with *Palythoa.* Into and through its crust were twined and twisted the suspending cords of the egg of a dog-fish, and in several places the indiscriminating zoophyte had erred from the glassy coil, and coated with a uniform and impartial layer, the cords of the dog-fish's egg!

The glassy whisp of *Hyalonema* is certainly very remarkable, but it is not entirely without analogy. *Hyalonema* seems to represent the extreme form of a little group of sponges, including, with probably a few other known forms, *Euplectella* (*Alcyoncellum*) *speciosa* (Quoi and Gaimard), and *E. cucumer* (Owen). The latter of these is an oval sponge, with silicious spicules whose form is somewhat analogous to that of the spicules of *Hyalonema.* From one end of the sponge a tuft of long silicious threads, resembling in structure those of the Japan sponge, twine round a stone, or other foreign body. Dr. Bowerbank isolated one of these spines of *Euplectella,* three inches long.

DESCRIPTION OF THE PLATE.

Fig. 1. *Hyalonema Sieboldi* (Gray), from a specimen in the British Museum.

Fig. 9, fragment of the upper part of one of the large needles of the coil; Figs. 2—8, 10, various forms of spicules.

THE STAR CHAMBER: ITS PRACTICE AND PROCEDURE.*

BY FRANCIS W. ROWSELL,

Barister-at-Law.

THE only complete treatise on the practice and procedure of the Court of Star Chamber which has come down to us was written by William Hudson, Barrister, of Gray's Inn, who practised in the court. Hudson did not publish his book, having, probably, before his eyes the terrors of a tribunal that fined, without respect to the *salvo contenemento* clause of the great charter, all who spoke "with great severity against it," and which "sometimes invented punishments in some new manner for new offences." So wholesome a fear had the author of his subject, that even in the manuscript (which he did not mean to publish) he declined to discuss the nature of the jurisdiction of the court. "I will not," he says, "dispute *de jure et de facto*, but declare, as briefly as I can, what matters are there usually determined." Hudson left the manuscript to his son, who gave it, as appears by a note appended to it, to Chief Justice, afterwards Lord Keeper, Finch, on the 19th December, 1635. The book was first printed and published in 1791–2, in the *Collectanea Juridica*, two volumes of *Tracts relating to the Law and Constitution of England*. The original manuscript is No. 1226, vol. i. of the Harleian MSS. From the printed copy in the British Museum the following particulars relative to the Court of Star Chamber have been chiefly drawn.

As to the name of the court, Hudson says it was not derived from the ornaments of the room in which the sittings were held. He says, "I suppose the name to be given according to the nature of the judges thereof"; and to explain what he means, he talks some nonsense about the judges being stars who shine by the light reflected from the king, the sun of their system. He further says, that the name could not be derived from the ornaments, for they were in the room because they were the device on the seal of the court. Content with

* 1. *A Treatise of the Court of Star Chamber.* By William Hudson.

"This treatise was compiled by William Hudson, of Gray's Inn, Esquire, one very much practised and of great experience in the Star Chamber, and my very affectionate friend. His son and heir, Mr. Christopher Hudson (whose handwriting this book is) after his father's death gave it to me, 19 December, 1635.

"JO. FINCH."

(Lord Keeper—temp. Chas. I.)

2. *An Essay upon the Original Authority of the King's Council.* By Sir Francis Palgrave, K.H. Published by the Record Commissioners, 1834.

this derivation of the name, Hudson goes on to show how ancient a name it was, and quotes from a complaint made in 40 Edward III., by Elizabeth Studley on account of some wrong done to her by James Studley, upon which James Studley was ordered to appear before the Chancellor and other lords of the council, assembled in "*le chambre de estioles pris de la receipt*" (Exchequer) at Westminster.

The name has been derived from the Saxon ꞅꞇeoꞃan, "to steer or govern;" and also from the *crimen stellionatus*, "cozenage," which the court punished; whilst Blackstone suggests the most reasonable origin of all when he observes that before the banishment of the Jews from England by Edward I., the Jewish covenants or contracts were called *starra* or *starrs*, a corruption of the Hebrew *shetàr*. These covenants were, by an ordinance of Richard I., directed to be enrolled and kept in chests under three keys, in certain places, one of which was the Exchequer at Westminster; and no starr was valid unless it could be found in one of these depositories. The room in which they were kept in the Exchequer was probably called the "starr" chamber; and Blackstone suggests that when the Jews were driven out, their covenants were destroyed, and the room in which they had been kept was appropriated to the use of the Privy Council. Sir Francis Palgrave, in his *Essay on the Original Authority of the King's Council*, says, "When Parliament assembled at Westminster, some of the principal chambers of the ancient and splendid palace were allotted for the despatch of business. The Commons sat in the Chapter-house of the adjoining abbey. But the Painted Chamber, the White Chamber, and the Chambre Markolph—probably so-called from the legendary tale relating the trials to which the wisdom of Solomon was subjected by a Syrian peasant, depicted on its walls—were occupied by the triers and receivers of petitions. The council itself, whether 'Parliament' was assembled or not, held its sittings in the 'Starred Chamber,' an apartment situated in the outermost quadrangle of the palace, next the bank of the river, and consequently easily accessible to the suitors, and which at length was permanently appropriated to the use of the council."

It has been a common error to date the foundation of the Star Chamber from the third year of Henry VII. Even Lord Andover, who, in 1640, had charge of the bill which passed into "an act for regulating the Privy Council, and for taking away the court commonly called the Court of Star Chamber," erroneously referred to 3 Henry VII. c. 1, as the statute which had first founded the court. "This," he says, "was the infancy of the Star Chamber. But afterwards the Star Chamber was, by Cardinal Wolsey, in the 8 Henry VIII.,

raised to man's estate, from whence (being now altogether unlimited) it is grown a monster." The truth is, the statute of Henry VII. was the first statute that recognized the existence of the Star Chamber, and conferred upon it judicial power; but the court or council, or both in one, existed long before Henry's reign. If we go to the length Hudson does, we shall have to believe what he certainly suggests, that the Star Chamber was "the council" referred to when a man was told that he stood "in danger of the council" for saying to his brother "Raca." But without carrying the matter quite so far back, it will be found that in Edward the First's time distinct mention is made of the Star Chamber, which appears to have exercised the mixed functions of a judicial and governmental council. At this time it was composed of the chancellor, the treasurer, the justices of either bench, the escheators, serjeants, some of the principal clerks in Chancery, "and such others—usually, but not exclusively, bishops, earls, and barons—as the king thought fit to name." Palgrave says: "On certain occasions it appears that the official members sat and acted alone; but that on others they were united to the rest." This council is the same body which is alluded to in very many statutes subsequently to Edward I. as that before which offenders in certain cases are ordered to appear, and by some of which authority is given to the "King's Council" to do certain things. Hudson says, when ridiculing the notion that his favourite court was established by the statute of Henry VII., that it is "a doating which no man that hath looked upon the records of the court would have lighted upon."

In order rightly to understand the constitution of the court, and to trace the source whence it derived its authority, it should be remembered that there were three councils known, in practice at least, to the English law—the Commune Concilium, the Magnum Concilium, and the Privatum Concilium. Of these three, the first was the general assembly of the military tenants of the crown, answering to the House of Lords of to-day; the second was that large committee of the first to which the king looked for advice in his government, and to which he referred petitions and complaints made to himself; the third was a select committee of the second council, supplemented by certain judges and serjeants, who sat as assessors. To this select committee were sent, in the course of time, not only all questions as between subject and subject, which had been submitted by petition to the king, or his Magnum Concilium, but also all complaints—and they seem to have been pretty numerous—of misconduct and injustice on the part of the royal officers. If the second council may be said to have borne to the first the same relation that the Privy Council now

bears to the House of Lords, the third council may be said to have borne to the second a relation somewhat similar to that which the Judicial Committee of the Privy Council now bears to the Council itself.

From hearing complaints upon petition, to instituting proceedings on its own account, whether by causing the Attorney-General to bring informations against particular persons before it, or by summons under the privy seal, was neither a long nor a difficult stage in the progress of the court; and we find—the troublous times of Henry VI. favouring the growth of excesses of all kinds—that in the reigns of Henry VI. and Edward IV. the select committee of the Privy Council, while discharging those judicial functions of the council which it derived from the parent council, the House of Lords, arrogated to itself a power in criminal causes which was often beneficially exercised, but was too unbounded not to tempt the wielders to abuse it.

A glance at the headings of many of the earlier statutes, a cursory glance at the roll of the Exchequer, will show the crying need there must have been for some supreme and powerful judicial arm to overawe the passions of vindictive officers acting in the king's name, and to counteract the wide-spread disease of the "itching palm," which caused the judges to sell, delay, and pervert justice. The fact that statutes were passed against judicial crookedness and rapacity, is proof enough that such crookedness and rapacity existed; and when we find entries on the roll of the Exchequer of so many hens, of a butt of wine, of money given to the king that the giver might "have justice," we are tempted to ask, Who guarded the guardians of the right? The 52 Henry III. (the statute of Marlbridge) c. 11, forbids the payment of a fine to the judge to induce him to grant a fair hearing; the statute of Westminster the First, 3 Ed. I. c. 25, forbids the clerks of the court to encourage litigation for the sake of the court fees; the 38 Ed. III. st. i. c.12, provides a punishment for jurors who take bribes; the 20 Ed. III. st. iv. c. 1 and 2, prohibit the judges from taking fees, or giving counsel in suits to which the king is a party; and there are others of a like nature here and there in the statute-book, down to the 3 Hen. VII. c. 1, which last act shows in its preamble the necessity that still prevailed for curbing judicial wickedness in high places.

The statute 3 Hen. VII. c. 1, is called *An Acte geving the Court of Star Chamber authority to punyshe dyvers mysdemeanors.* It recites that "the King our Sovereign Lord remembereth how, by unlawful maintenance, giving of liveries, signs, and tokens, and retainers by indenture, promises, oaths, writing or otherwise, embraciaries of his subjects, untrue

demeaning of sheriffs in making of panels, and other untrue returns, by taking of money by juries, by great riots and unlawful assemblies, the policy and good rule of this realm is almost subdued"; and then goes on to ordain that "the Chancellor and Treasurer of England for the time being, and the Keeper of the King's Privy Seal, or two of them, calling to them a bishop and a temporal lord of the King's most honourable Council, and the two Chief Justices of the King's Bench and Common Pleas for the time being, or other two justices in their absence, upon bill or information put to the said Chancellor for the king, or any other, against any person for any misbehaving afore rehearsed, have authority to call before them, by writ or privy seal, the said misdoers; and them and others by their discretions to whom the truth may be known to examine; and such as they find therein defective, to punish them after their demerits, after the form and effect of statutes thereof made in like manner and form as they should and ought to be punished if they were thereof convict after the due order of the law."

The reasons why such a court as the Star Chamber should exist, and the sort of authority Parliament intended to give it, are thus set forth, at the same time that it is evident the power conferred by the act is given to a court already in existence, and specially described as "the Court of Star Chamber." Lord Bacon, writing of the Star Chamber, says: "This court is one of the sagest and noblest institutions of this kingdom. For in the distribution of courts of ordinary justice, besides the High Court of Parliament, in which distribution the King's Bench holdeth the pleas of the crown, the Common Pleas pleas civil, the Exchequer pleas concerning the king's revenue, and the Chancery the pretorian power for mitigating the rigour of law, in case of extremity, by the conscience of a good man; there was, nevertheless, always reserved a high and pre-eminent power to the King's Council in causes that might, in example or consequence, concern the state of the commonwealth, which, if they were criminal, the council used to sit in the chamber called the Star Chamber; if civil in the White Chamber, or Whitehall. And as the Chancery had the pretorian power for equity, so the Star Chamber had the censorian power for offences under the degree of capital. This court of Star Chamber is composed of good elements, for it consisteth of four kinds of persons—counsellors, peers, prelates, and chief judges. It discerneth also principally of four kinds of causes—forces, frauds, crimes various of stellionate, and the inchoations or middle acts towards crimes capital or heinous, not actually committed or perpetrated. But that which was principally aimed at by this act was force, and the two chief

supports of force, combination of multitudes, and maintenance or headship of great persons."*

Up to the time when, as Palgrave says, "the Star Chamber raged with savage vigour for the punishment of mere political offences," it would not seem that the court had drawn any great amount of odium to itself by acts of tyranny done in the name of justice. There were, now and again, complaints made that the council took notice of causes which ought to be tried at common law; but, on the whole, the court had worked for the public good, discharging some of the functions which are now exercised by the courts of Chancery, Queen's Bench, Admiralty, and Probate, and constituting, in criminal matters, a kind of court of conscience, administering justice rather according to the particular circumstances of the case than the law of it, and having the advantage of freedom from the forms and trammels of the common law procedure. It could adjourn a case for further evidence, which a law court could not; it could examine and cross-examine the principals in a cause civil or criminal, and it was entirely free from the highly technical system of pleading which often worked injustice in the common law courts. Whether a civil and a criminal court, erected out of distinct committees of the Privy Council, sat at the same time and by virtue of the same authority, as Lord Bacon would seem to suggest, is a question involved in much obscurity; but it is at least not irreconcilable with his statement to suppose that the same members of the Privy Council discharged both the civil and criminal functions of that body, only changing their place of meeting according to the business

* It is but right to state what that great father of English law, Sir E. Coke, who was to Francis Bacon what the Chief Justice of to-day is to the youngest barrister that is "sure to make his way," says on the subject of the Star Chamber.

Sir E. Coke (*Institutes*, Part 4, c. 5) begins by showing out of the Rolls of Parliament and Year Books the nature of the cases triable in the Star Chamber. These are identical with those set forth in the present paper. He then says that formerly the Court sat rarely, because it was not often that flagrant occasion was given for its interference; and because then it did not meddle with causes which the other Courts were competent to try. He goes on to show that the statute of Henry VII. did not originate the Court of Star Chamber, and claims to the credit of the Court that it dealt with offences "especially of great men," . . . . . . "to the end that the medicine may be according to the disease, and the punishment according to the offence."

Sir E. Coke says the Court is named of "Star Chamber" because "the roof is starred." He explains the holding of the Court *coram rege et concilio* to mean,

1. Before Lords and others of his Majesty's Privy Council.
2. Before the Judges of either bench, and the Barons of the Exchequer.
3. Before the Lords of Parliament, who however were not standing Judges unless they were also Privy Councillors.

And he had so high an opinion of the Court that he says, "It is the most honourable Court (our Parliament excepted) that is in the Christian world, both in respect of the Judges of the Court, and of their honourable proceedings according to their just jurisdiction, and the ancient and just orders of the Court."

they had to transact. Sir Francis Palgrave, however, would appear to think that the criminal jurisdiction of the Privy Council was alone vested in the Court of Star Chamber, the jurisdiction in civil causes being retained by the body of the council. For, after stating that the statute of Henry VII., which declared the authority of the court, and the 21 Henry VIII. c. 20, which added the President of the Council to the other members, "virtually created the Court of Star Chamber as it existed under the Tudors," says: "The Privy Council, sitting as such at Whitehall and Greenwich, gradually abandoned its criminal jurisdiction to those of its members who assembled at Westminster, conjointly with the justices of either bench, and under the direction of the Lord High Chancellor." Though it is quite likely that the Privy Council reserved to itself the right to hear any complaint which might be brought before it, notwithstanding it had delegated so much of its judicial power to its committee—a right which privy counsellors sometimes questionably claimed to exercise by taking their seats at the board in the Star Chamber, though they were not regular members of that court—it is certain the council, as such, did not, at least under the Tudors and the Stuarts, habitually sit as a court of appeal or as a court of first instance. Whatever the theory might have been, the practice was, since the declaratory act of Henry VII., for the Star Chamber to discharge both the criminal and civil business of the council. It will be as well here to ascertain what power was actually wielded by the Star Chamber, what the procedure in the court was from summons to execution, and then to indicate the causes which led to its ruin.

The Court of Star Chamber had jurisdiction both in civil and criminal causes, and could enforce its sentences by any punishment short of death, and dispossession of freeholds. Even these two extreme punishments it was able to inflict by indirect means, as will be shown later on.

As a court of civil law, it entertained suits by the king's almoner for the delivery of deodands, and the goods of suicides, felons, etc. It also took cognizance of "great matters of interest betwixt the king and his subjects, which are accompanied with conveniency of state as well as *meum and tuum.*" One large branch of its practice lay in the hearing of causes against corporations, abbeys, great lords, and others whom it was difficult to reach through the common channels of the law. It was a reason very frequently given for applying to the council that the defendant was a person of so great influence that a fair trial could not be had at common law. Alien merchants, women who had been cheated of their jointure, suitors in testamentary matters, in prize claims, in actions for

collisions at sea, and the people of Jersey and Guernsey, appeared as parties to actions in this court. No other means of redress were available for them, and so long as the Star Chamber furnished the means, it was doing good service, and no one felt disposed to question too closely the soundness of its jurisdiction.

Whenever a question arose involving the title to a freehold, the practice of the court was to send the issue to be tried in one of the common law courts, and when the return was made to proceed with the cause to which such question had been incidental. As a court of appeal, it does not seem to have done much, though theoretically an appeal lay to it from the courts of the Wardens of the Marches, the courts of the Stanaries, and those of the counties Palatine; and there are instances recorded of writs of *certiorari* addressed to these courts, ordering cases which had been brought before them to be transferred to the Court of Star Chamber.

As a criminal court, the jurisdiction extended to "cases which in strictness of law cannot be otherwise questioned, and may be here examined"; causes of special limitation by Act of Parliament; and causes which were also cognizable by the courts of common law. The way in which the court laid hold of offences of the class last mentioned may be best stated in Hudson's own words. He says: "Being now to treat of criminal causes I must begin with the highest, and therein I shall show that all offences may be here examined and punished, if it be the king's pleasure, as treason and murder, felony and trespass; but then are not all these offences punished as trespasses, and not capitally; for if it please the king to remit his justice, and yet not so that the world shall have notice of the offence, he may call a traitor to this bar, and take acknowledgment, and fine and ransom him." Thus it was under a show of mercy, of a desire to mitigate the severity of the law, without setting the law aside, that cases which were properly triable at common law, were brought into the Star Chamber; and the benefit supposed to accrue to a man in consequence was deemed to outweigh the disadvantage of trial by persons who were not his peers, nor sworn to do justice in his particular case. Hudson is of opinion that this last was very far from being a disadvantage, for he says, "subjects may as safely repose themselves in the bosoms of those honourable lords, reverend prelates, grave judges, and worthy chancellors, as in the heady current of burgesses and meaner men, who run too often in a stream of passion after their own or some private man's affections." The tender considerations of the prince for his erring subjects, his refusal even at the cost of violations of the constitution, to hand them over to condign

punishment, which would only have the effect of hardening or destroying them, are ingeniously put by the apologist of the court; but though there might be some ground for this assertion with reference to Plantagenet times—but then the criminal jurisdiction of the Star Chamber was not developed —people will not be disposed to give the princes of the House of Tudor still less of the House of Stuart, credit for so much disinterestedness and exalted virtue. They will, it is to be feared, rather think that the power to "take acknowledgment, fine, and ransom," of people who else would be destroyed or imprisoned at the king's expense, for their offences, was the reason why common law offences should have been drawn into the Star Chamber. As a matter of fact this was so. Empson and Dudley set the hateful example of exacting enormous fines under colour of a judicial sanction, which was not based upon any known rule of law, but was dictated by the caprice of the judge or the emptiness of the exchequer at the moment. Though these men were punished for their temerity, their example had many imitators. Ruinous fines were inflicted for offences perfectly venial, without any regard to that clause of the Great Charter, which forbids the imposition of such a fine as will disable a man from earning his livelihood. Even Hudson speaks of the fines as "trenching to the destruction of the offender's estate, and utter ruin of him and his posterity."

The causes which "in strictness of law cannot be otherwise questioned, and may be here examined," included forgery, perjury, riot, maintenance, fraud, libel, and conspiracy. The perjury was not merely that committed by a witness *coram judice*. For such an offence punishment was provided by 5 Elizabeth c. 9, which inflicted a fine of twenty pounds, or in default sentenced the delinquent to the pillory and nailing of both ears. In considering punishment, the Star Chamber acted analogously to the statute, but extended its authority very much further. It punished perjuries committed by jurymen, who gave a verdict against the evidence, or sold their verdict, or did anything which the Star Chamber, judging of fact, law, and punishment, deemed to constitute perjury; and this last came to mean that any jury which had given a verdict contrary to what the court thought should have been given, was "in danger of the council." There are many instances of heavy fines imposed upon juries, one of the most celebrated being that of the jury in 4 and 5 Philip and Mary, which acquitted Throckmorton of treason, upon evidence which the Star Chamber thought sufficient to warrant a conviction. The jurors were imprisoned, and some of them attempting to justify themselves before the council, were fined in sums varying from two thousand pounds to a thousand marks each. Other

cases there are in abundance, but Hudson's words are conclusive to show the practice of the court toward those whom it considered to have broken their oaths to "well and truly try, and true deliverance make." He says, "And in the reigns of Henry VII., Henry VIII., Queen Mary, and the beginning of Queen Elizabeth's reign, there was scarce one term pretermitted but some grand inquest or jury was fined for acquitting felons or murderers." In this way the Star Chamber which refrained from sentences of death, sometimes intimidated juries into verdicts which were against their consciences and their oaths, for it was not often a jury made such a stand as that which acquitted Sir Nicholas Throckmorton. But before condemning wholly the practice of the court in regard to juries, it will be as well to ascertain whether there was any ground on which its practice might rest, and very little search will prove that there actually was such ground. Hudson cites a number of cases in which the jury had been "laboured" beforehand, and gave their verdict without regard to the evidence; but a less partial witness than he, Sir Francis Palgrave, in his treatise on the Privy Council already quoted, says, "trial by jury has been, and may be, so affected by the general position of society as to become an active instrument of mischief and oppression. Trial by jury may now be called a tribunal composed of the peers of the defendant or of the accused. It has become so, at least in theory, by the alteration of the law, which allows the jury to be the judges of the truth of the evidence given before them, but this practice is comparatively recent, and engrafted upon the ancient institution." The jurors in former times were in fact the witnesses, being summoned for the very reason that they knew or were supposed to know, about the facts in the cause to be tried. The sheriff was bound to summon such persons whose knowledge was often derived from no more than mere gossip, the hearsay of the village or the district. Jurors with minds already prejudiced, or so well informed upon the facts of the case as to allow of prejudices previously entertained having play, were the triers; and it is not remarkable that they often arrived at verdicts both improper and untrue. In much later times the difficulty has been experienced of procuring the only verdicts warranted by the evidence — *e. g.*, Welsh juries—imbued with local or national sympathies, and when the potency of such sympathies in remote ages, coupled with the constitution of the juries as already described is taken into consideration, one is able to see at least a possible need for the interference of the council in order to keep clean the fountains of justice. In the 33 Edward I., the king and council agreed upon a definition of "conspiracy," which was intended to include jurors. Those who bound themselves

"by oath, covenant, or alliance, that each will aid and sustain the other in falsely and maliciously indicting or causing to be indicted, *or in falsely acquitting*, or in raising and maintaining any false plea," were to be deemed conspirators. The courts of law, however, held that jurors were not within this definition, and the evil which the king and council intended to remedy, remaining unabated, the sovereign arm was kept stretched out until the evil having disappeared, while the remedy grew ever more powerful, it became itself to be an unbearable nuisance. But originally this was not so. Besides taking notice of perjury in the common law courts, the Star Chamber punished the same offence when committed in the Ecclesiastical, Stannary, and Chancery courts.

Riot included unlawful assemblies, forcible entries and detainers, waylaying for the purpose of committing an assault, assaults on privileged persons, and duels. These were, most of them, common law offences, but were triable in the Star Chamber by virtue of that extraordinary power which the court arrogated to itself in the course of time, and which was confirmed by 3 Henry VII. c. 1. With regard to duellists, though at times they were severely punished, especially if there had been any knavery in the arrangements for carrying out the duel, at other times the punishment imposed on them was no more than that the reprimand of the court should be read by the judge of assize, on his next arrival in the neighbourhood where the duel had taken place.

Fraud included conveyances and gifts in order to defraud creditors. Maintenance was not only the factious support given by great men to their inferiors in order to enable them to maintain their suits at law till the defendant, a person inimical to the lord, was weary to pursue his right or was ruined, but it included the meaner sins of pettifoggers who backed up a doubtful or a dirty case on the understanding that costs should come out of the other side.

Of the law of libel, which was moulded in the Star Chamber, Hudson says, "In all ages libels have been severely punished in this court, but most especially they began to be frequent about the forty-second and forty-third of Elizabeth, when Sir E. Coke was her Attorney-General. In the eye of the court a man was guilty of libel who "scoffed at the person of another in rhyme or prose"; if he personated him "thereby to make him ridiculous"; if he annoyed him by parading his effigy in a contemptuous manner; "or by writing of some base or defamatory letter, and publishing the same to others, or some scurvy love-letter to himself, whereby it is not likely but he should be provoked to break the peace; or to publish disgraceful or false speeches against any eminent

man or public officer." There are cases of convictions for libel where the accused "spoke certain words against the Lord Cardinal"; used uncivil words to the Sheriff of London; and in Elizabeth's time a man was pilloried for saying Lord Dyer was a corrupt judge. Whitelocke, a barrister, was charged before the court for having advised a client that a commission issued by James I. was illegal. John Selden was, in the same reign, summoned on account of a passage in his *History of Tithes*, whereby he had thrown doubt upon the clergy's claim of divine right to them. Some students of Lincoln's Inn were brought before the court for having at a wine party drunk "Confusion to the Archbishop!" (Laud). The informer against them was their own servant, and the Earl of Dorset, who sat at the council board, took advantage of the circumstance to excuse the students by suggesting that the man being constantly in and out of the room, had heard only part of the toast, which, he said, probably was, "Confusion to the Archbishop's enemies!" The students were dismissed with a severe reprimand. Publishers of a libel were as severely punished as the makers; and "to hear it sung or read, and to laugh at it, and to make merriment with it, hath ever been held a publication in law," says Hudson, who would also appear to be the high priest of that immoral doctrine, until recently taught by the English law, that the greater the truth the greater is the libel. For when citing a case in which a "scandalous letter" had been sent, he says with some show of indignation, "and yet the defendant would have undertaken to have proved the contents of the letter to have been true, he thereby charging himself (the plaintiff) with bribery and extortion in his place." Further on he mentions "two gross errors. 1. That it is no libel if the party put his hand unto it. 2. That it is not a libel if it be true; *both which have been long since expelled out of this court.*"

Conspiracy included false accusations and malicious prosecutions. A man named Lee was pilloried, lost his ears, and was branded with F. A. on the face, for accusing some lords of the Gunpowder Plot.

In virtue of its high jurisdiction, "which by the arm of sovereignty punisheth errors creeping into the Commonwealth, ... yea, although no positive law or continued custom of common law giveth warrant to it," the Star Chamber punished disobedience to royal proclamations; attempts to coin, to commit burglary or murder; and to extort money from foolish young men through the medium of infamous women feigning themselves married. It also punished uncivil conduct towards magistrates; arresters of privileged persons, the keepers of dicing-houses, and bowling alleys; enticers of young men into unthrifty marriages; engrossers of wares in order to raise the

price; spreaders of false news; entanglers of young men in money difficulties; invokers of evil spirits. Favouritism by sheriffs, troublesome behaviour on the part of members of guilds, misconduct of privy councillors, abuse of authority by officials—as when Latcher and Skinner whipped Mrs. Nevill in Bridewell—were all punished in the Star Chamber; "in a word, there is no offence punishable by any law, but if the court find it to grow in the Commonwealth, this court may lawfully punish it, except only where life is questioned."

Arrests were made under a privy seal, or on the warrant of the board. Summonses were issued by the same authority. The accused was privately examined, and encouraged to confess and submit himself to the mercy of the court, whereby he often met a lighter sentence than if the law were allowed to run its ordinary course with him. "But in all these cases this is a court rather of mercy than of justice, for if those capital offences should be proceeded against capitally, then must men be tried by course of indictment by their peers *per legem terræ*" (Hudson). If the prisoner confessed, his admission was written down, and shown to him when he was brought to the bar, and then if he recognized it, sentence was passed according to the discretion of the court; if he denied it, witnesses were called to prove it, and Hudson says that in such cases the court in his time often strained the confession unfairly against the prisoner. There was no jury, and the court needed not to be unanimous. The president had a casting vote.

Concerning punishments, Hudson says they are "now of late imposed *secundum qualitatem delicti*, and not fitted to the estate of the person so that they are rather *in terrorem populi* than for the true end for which they were intended." If this was true of Hudson's time, it was much more true of the time of the next and last generation of practitioners in the Star Chamber. The fines imposed by the court in Charles the First's reign were so wildly extravagant that they defeated the object of the imposers, unless, as was the case with the last judgments pronounced by the Star Chamber, the intention was to imprison indefinitely as well as to ruin irretrievably. Imprisonments were ordered in the Fleet, in the Tower, and formerly in the Marshalsea. Loss of ears was the lot of "perjured persons, infamous libellers, scandalors of the state, and such like." Branding in the face and slitting the nose were the punishments of forgers of false deeds, conspirators to take away the life of innocents, false scandal upon the judges, and first personages of the realm." Whipping was used in "great deceits," and in cases where "a clamorous person *in formâ pauperis* prosecuteth another falsely, and is not able to pay him his costs." There was also the punishment of "wearing papers," which,

notwithstanding, Hudson says it "hath been used in all ages," I have not been able to ascertain what it was. It seems to have been at one time the punishment for perjury, "but since Elizabeth, a punishment for oppressors and great deceits." "Sometimes the punishment is by the wisdom of the court invented in some new manner for new offences, as for Traske, who raised Judaism up from death, and forbade the eating of swine's flesh. He was sentenced to be fed with swine's flesh when he was in prison." In a civil cause damages were assessed by the court, the intervention of a jury being a thing unknown there.

The orders and sentences of the Star Chamber were enforced, and contempts were punished by fine and imprisonment; but Hudson says, and we may without any effort believe him, "there was scarce a man found so impudent as would struggle with the sentence of this high court."

Such were the practice and procedure of the Star Chamber administering the judicial powers of the Privy Council. So great an authority, so undefined, and so avowedly beyond the control of either statute or common law, could not fail to be abused, however beneficial the exercise of it might originally have been. As satisfying a want which the known law did not meet, as a corrector of abuses, "creeping into the Commonwealth," as the curber of licentious and violent persons, and as the means of putting in action the king's *patria potestas* for the protection of women, wards, and adolescents, and for other domestic purposes, the Star Chamber was well suited to the men and manners of a half-barbarous era. It was, also, perhaps, justified by the exceptional position in which Elizabeth and her government found themselves, and it is certain that in Elizabeth's reign the authority of the Star Chamber was at its height. But such an institution was altogether unfitted for Englishmen of the time of James I. and Charles I. The ills which it was designed to remedy had, many of them, disappeared, and such as remained the common law courts and the Court of Chancery were quite able to cope with. As a matter of fact, the Star Chamber had of late years relinquished to those courts a vast amount of its business. It applied itself as an instrument of state rather than of law, to the punishment of "mere political offences," and gradually intensified the extravagance of its decrees till it raged with that "savage vigour" which procured its overthrow.

Almost the first business of the House of Commons in the first Session of 1641 was to take into its serious consideration the petitions of Prynne, Burton, Bastwick, Alexander Leighton, and Lilburne, who had suffered the worst of the Star Chamber's terrors, for offences purely political, and some of

them so trifling, even when judged by the Star Chamber's rules, that had there not been vengeance to satisfy, much more than a desire to prevent inconvenience to the State, the petitioners could not have been sentenced to the dreadful punishments of which they underwent the most ignominious part. The debate, as reported by Rushworth, will well repay the labour of reading it. The result of the debate was the appointment of a committee, upon whom was laid the duty of examining into the merits of the petitions. The petitioners were released from the dungeons into which they had been flung by the *patria potestas;* and Lord Andover, upon the report of the committee, obtained leave to bring in his Bill for the abolition of the Star Chamber. Either intentionally or ignorantly, probably the former, he gave the go-bye to the fact that the Star Chamber had existed before the statute of Henry VII., and taking that statute for his standpoint, as the first which had recognized the court at all, he proceeded to show how the authority conferred by it had been abused. The House of Commons passed the Bill, and sent it to the Upper House. Their lordships desired a conference, and proposed that the Star Chamber, instead of being abolished, should be once more restricted in its operation to the statute of Henry VII. But the Commons were determined to wipe out the blot altogether from the Constitution, and after a slight resistance the Lords passed the Bill.

The 16 Charles I., c. 10, *An Act for the Regulating the Privy Council, and for taking away the Court commonly called the Star Chamber,* recites a number of statutes relating to the council, and the two statutes relating to the Star Chamber, and with special reference to the 3 Henry VII., c. 1, says, "But the said judges have not kept themselves to the points limited by the said statute, but have undertaken to punish where no law doth warrant, and to make decrees for things having no such authority, and to inflict heavier punishments than by any law is warranted"; and because matters taken before the Star Chamber can be taken in the ordinary course of justice, elsewhere and by common law; "and forasmuch as the reasons and motives inducing the erection and continuing of that court do now cease, and the proceedings, censures, and decrees of that court have by an experience been found to be an intolerable burden to the subjects, *and the means to introduce an arbitrary power and Government*"; and also because of the mischievous meddling of the court in civil causes, whereby "great and manifold mischiefs and inconveniences have arisen and happened, and much uncertainty by means of such proceedings hath been conceived concerning men's rights and estates," the Act goes on to abolish in the most sweeping

way the hateful court, and to forbid the restoration of it or the erection of any court like it.

This was a bitter morsel for Charles to swallow. It deprived him of the power to enrich his treasury by fines which could be imposed at the discretion of his own councillors; and it took away that power, yet dearer to arbitrary men, of vindictively pursuing and cruelly punishing those who dared to resist his ordinances. It was tendered for his assent along with the bill for abolishing the High Commission; and when, on the 3rd July, 1641, the king came down to the House of Lords to give his assent to a number of bills, it was supposed these two would have been among them. The discontent which followed upon the discovery that these bills were held over, expressed itself so strongly that it reached the king's ears. Charles came down on the 5th July, and assented to the abolition bills, and referring to the discontent, said, "Methinks it seems strange that anyone should think I could pass two bills of that importance that these were, without taking some fit time to consider of them; for it is no less than to alter, in a great measure, those fundamental laws, ecclesiastical and civil, which many of my predecessors have established."

INDIAN INSECTS—HOUSE VISITANTS.

BY THE REV. R. HUNTER, M.A.

Towards the middle of June, when the Indian hot season is about to terminate, let the eye turn where it will, it sees vegetation languishing and all but dead. For eight months previously there has scarcely been a shower; for two and a half there has blown a wind, hot as the blast of a furnace, which has reduced rivers of respectable magnitude to brooks, and has left streams of inferior size literally dry channels. Trees or plants with leaves of a lively green are scarcely to be met with, except in gardens where appliances exist for artificial irrigation. The animals have crept away into corners, and are at no season of the year less obtrusive. Indeed, one great section of the animal kingdom—the insect class—is almost wanting, the greater number of its varied tribes existing at that season in the chrysalis state.

But by and by, clouds, escaping over the tops, or through the passes of that great rocky rampart which figures in maps as the Western Ghauts, pile themselves around the central Indian sky. After having several times threatened rain, and again withdrawn the menace, till the repeated crying of "wolf,

wolf" has produced the usual effect of making people pay little or no attention to the warning voice, even when it sounds more earnest than usual, they finally begin to discharge themselves on the earth. Sometimes the rainy season (caused by the south-west monsoon) comes on gradually: more commonly, however, a magnificent thunder storm inaugurates its reign. The dry and thirsty land in a few hours becomes green as emerald, and the animals reassert their place in creation. It would scarcely be relevant to the present subject to point out the several elements which go to constitute the wondrous transformation so gladdening to the eye: it is enough to note the phenomena presented by the insect world.

Within a week after the rainy season has established itself, the number of insects which have quitted the state of suspended animation, if one can call it so, and flown forth from their living graves, is very great, nor are their beauties withheld from human observation. The night has just set in, outside the atmosphere is moist, inside it is somewhat close, and Paterfamilias, in sitting down to tea, directs that the doors shall be thrown open. The order is carried out, when a multitude of uninvited guests at once present themselves, attracted, it must in justice be stated, not by his viands, but by the argand lamp which burns so brilliantly upon his table. They are insects of very varied families. On the first two or three occasions when this occurs, the novelty of the spectacle makes one reluctant to interfere with it in any way; but before long scientific ardour receives a check of an unromantic character. As roughs may intermingle with thoroughly respectable processionists, so flying bugs, especially a black species, troop in at the door with the rest of the insect world, and, being somewhat clumsy in their flight, are exceedingly prone to fall full length into the cups of tea. Their smell is precisely that of the domestic pest to which they have so close an affinity; and we fancied, though it may have been no more than fancy, that they imparted both that, and a peculiar taste to the tea into which they tumbled, so that in all cases the cup degraded by the presence of such visitants was sent away. It was therefore found the best policy to keep the doors closed till tea was over, and then fling them open, to afford ingress to the insect crowd waiting outside. When at length leave was granted, the rush began. In they trooped, great and small, representatives of this, and representatives of that order: all directing their way to the common centre of attraction, the lamp upon the table. It was impossible to prevent many from burning their wings or perishing in the flame.

The *Coleoptera* figured in large numbers, many distinct families sending each a contingent to the general muster. One

or two predatory *Cicindelas* were there, though smaller in size, and more sombre in colour than the pretty species of this country. The lamellicorn beetles came; but there was nothing to wonder at in this: it being very common, even when other insects were absent, for a species of this tribe, belonging to the genus *Bulboceros* to wing its droning flight in at the door, and up and down the room, after which it was wont to tumble backwards on the ground, and lie struggling for some time before it could regain its footing, or acquire lever power sufficient to rise upon the wing. Species of genera with soft elytra were, beyond others, numerous in individuals; and this was remarkable about them, as it was indeed more or less of all the other families, that every fortnight or so, the species changed, those that were common at the beginning growing more rare, and those of which there had been seen but a single individual or two becoming numerous.

One of the *Cimicidæ* has been already mentioned. Other *Hemiptera* presented themselves for observation, the one that left the deepest trace upon the memory being a large *Reduvius*, which on being seized, would turn round, and with its suctorial mouth inflict a deep envenomed wound on the finger.

The *Orthoptera* sent to the assembly some species of the locust family, this being noticeable about their habits that, whereas the other insects, while they remained with us, kept with tolerable steadiness to the table, and somehow managed to take themselves off altogether before morning, these, after having had enough of the table, manifested certain proclivities towards the wall, with which they soon made acquaintance and from which they were in no hurry to depart, for they were often to be seen standing there in a sleepy way after sunrise.

A very interesting Neuropterous insect, though not abundant, was still occasionally to be met with—the *Myrmecoleon* or ant lion. It was like a dragon fly, but had much more conspicuous antennæ, and doubtless came from the neighbouring hill, where its larvæ might be disinterred from the bottom of small funnel-shaped holes in the light sandy soil. But of all the *Neuroptera* none figured so conspicuously as the *Termites* or white ants. They were in company with a large black ant of the *Hymenopterous* order, to which they seemed in some way mysteriously drawn. The *Termites* which flew around the lamp had four gauzy wings, but attached to them so lightly that when they dashed against any solid body, their wings flew off, and they became degraded into creeping things, very much like ear-wigs but without the forceps.

The curious insect-drama never looked more anomalous than when it was enacted during the time of divine service in church.

In all probability the lights on either side of the pulpit were brighter than those in other parts of the sacred edifice, and, in consequence, the stream of insect church-goers winged their way thither in quest of enlightenment. Some, loving it "not wisely but to well," soon fell a sacrifice to their ardour; others, directing their course more skilfully, danced in mazy circles around the attractive object, as planets might revolve about a central sun. Some white ants struck the face of the preacher, others deemed his neck the proper target against which to direct their energies, and inpinging upon it, fell as creeping things upon, or occasionally inside his dress; while, if he aimed at reading correctly, it was necessary for him from time to time to brush away the wings from his book.

It were well worth the while of those British entomologists who have correspondents in India to obtain from them *all the species* that frequent these tea-table gatherings, requesting at the same time that accurate note may be taken of the date at which each species first appears, the time when it reaches its maximum in point of numbers, and that again at which it has so far declined that it can scarcely be met with. Such an investigation, if prosecuted simultaneously in various parts of India, and the results compared, the identifications of course not being left to the local observers but undertaken by eminent entomologists at home, could not fail to prove interesting in a high degree.

THE CLIMATE OF GREAT BRITAIN.

BY RICHARD A. PROCTOR, B.A., F.R.A.S.

If there is one feature in the material relations of a country which may be considered as characteristic—as of itself sufficient to define the qualities of the inhabitants, and the position they are fitted to occupy in the world's history—it is climate. "It includes," says Humboldt, "all those modifications of the atmosphere by which our organs are affected—such as temperature, humidity, variations of barometric pressure, its tranquillity or subjection to foreign winds, its purity or admixture with gaseous exhalations, and its ordinary transparency—that clearness of sky so important through its influence, not only on the radiation of heat from the soil, the development of organic tissue and the ripening of fruits, but also *on the outflow of moral sentiments in the different races.*" I do not propose, however, to deal with the constitution of the climate of Great Britain, under this general view. To do so, indeed, would

require somewhat more space than the readers of the INTELLECTUAL OBSERVER would willingly see allotted to a single subject. I wish chiefly to consider the subject of temperature (mean annual and extreme winter or summer); though I may, perhaps, have a few words to say respecting that feature of our climate, which most foreigners consider to be its chief defect—the want of transparency or clearness in our skies as compared with those of some other European countries.

The mean annual temperature of a country is less important to the welfare of the inhabitants than the extreme range of temperature exhibited in the course of the year. Of two countries which have the same mean annual temperature, one may have a climate most admirably adapted to the welfare of its inhabitants, while the other may have a climate offering such fierce and violent extremes of heat and cold that its inhabitants resemble the unfortunates described by Dante, doomed

"—— a soffrir tormenti caldi e geli."

However, I shall deal first with this feature—mean annual temperature—as affording a starting point from which to proceed to other considerations.

If the surface of the earth were perfectly uniform, or symmetrically distributed into districts of land and water arranged in zones along latitude-parallels, and if the strata of the soil were throughout of like density, radiating power, and elevation, the lines of equal mean temperature would be parallels of latitude. This hypothetical condition of things is, we know, very far from representing the true condition of the earth's surface. Land and water are distributed in a manner which hardly presents the semblance of law; elevations and depressions, not merely of areas of limited extent, but of whole countries, are exhibited in each hemisphere; and endless diversities of soil, contour, and distribution, disturb that mathematical uniformity and exactness, which could alone produce the co-ordination of climates under latitude-parallels.

It is to Humboldt that we owe the valuable proposition that maps of the world should exhibit *parallels of heat*, as well as latitude-parallels; and no atlas is now considered complete without maps in which *isotherms*, or lines of equal mean annual temperature, *isochimenals* or lines of equal winter heat, and *isotherals* or lines of equal heat in summer, are exhibited. These lines are usually presented in maps on Mercator's projection, an arrangement which has some advantages, but is not, on the whole, very well suited to exhibit the true conformation of the isothermal lines—the study of which, it has been well remarked, constitutes the basis of all climatology.

In Figs. 1 and 2, the northern hemisphere of the earth is

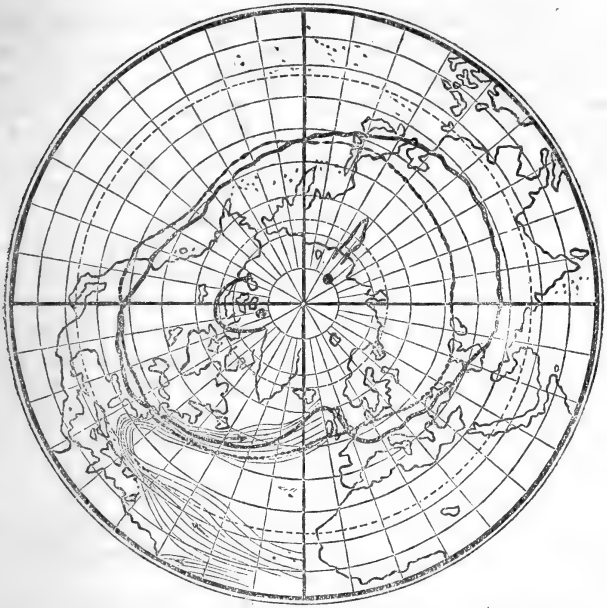


FIG. 1.—Midwinter and Mean-Annual Isotherms of London.

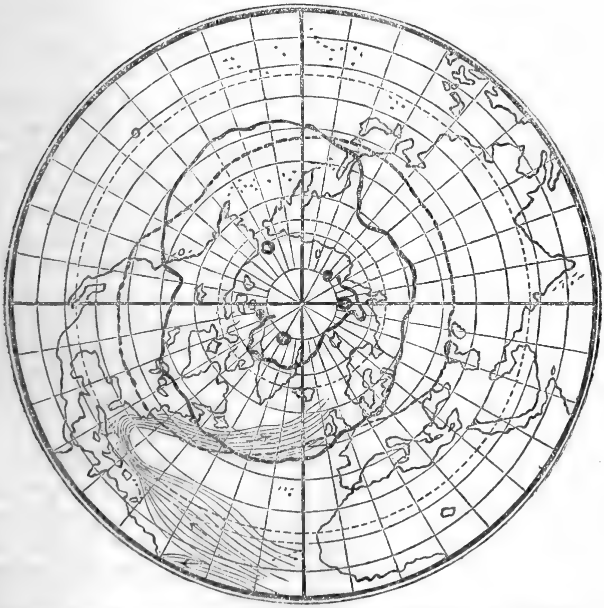


FIG. 2.—Midsummer and Mean-Annnal Isotherms of London.

presented on a projection (the equigraphic) which has been already discussed in these pages.* The smallness of the scale would not readily permit of the introduction of the system of isothermal lines usually presented, therefore I have only introduced the isotherm which passes through London. In both figures this isotherm is represented by a dotted closed curve passing across the south of England, thence across the Atlantic in a south-westerly direction, and across the continent of America nearly on the latitude of New York. After it has entered the Pacific Ocean, the isotherm passes somewhat northwards, but trends southwards again as it nears the Asiatic continent, reaching its greatest southerly range in the sea of Japan, traversing Asia nearly on the latitude of the Aral sea, and thence passing somewhat northwards through the Crimea, Vienna, and Brussels to London. Along its whole extent the isotherm nowhere has a higher latitude than where it crosses the British Isles; in other words, the mean annual temperature of Great Britain is higher than that of any country lying between the same latitude-parallels. The advantage of this arrangement is second only in importance to that which England will be seen to possess, when we come to consider the extreme range of temperature during the year. In fact, England is thus brought to the centre of the true temperate zone of the northern hemisphere; since the consideration of Figs. 1 and 2 will show that the isotherm of London approaches as near to the tropic of Cancer in one part of its course, as to the Arctic circle in another.

Before leaving this part of the subject, let me note a circumstance, not immediately connected with the climate of Great Britain, but geographically interesting. In examining the polar presentation of the London isotherm, we see that in two parts of its course it exhibits a tendency to travel northwards, and becomes, in fact, *convex* towards the pole. If we traced in isotherms of greater mean temperature—that is, nearer the equator—we should find this peculiarity gradually diminishing. But if we traced in isotherms of lower mean temperature, we should find the convexities gradually becoming sharper and more defined, approaching each other more and more nearly, until finally they would meet, and the isothermal curve be divided into two irregular ovals. Proceeding to trace out curves of still lower temperature we should find the two ovals closing in towards two poles of cold. These are indicated in Figs. 1 and 2 by two black spots, one north of the American, the other north of the Asiatic continent. It is to be noted, however, that at the American pole the mean annual tempera-

* See the number for July, 1866. The term *isographic* is etymologically preferable to the hybrid word equigraphic.

ture is not quite so low as at the Asiatic pole, the former temperature being $3\frac{1}{2}°$, the latter 1° Fahrenheit.

Returning to our subject, let us consider the all-important question of range of climate. The effects of climate, unimportant to the stronger inhabitants of a country, but largely influencing the health and comfort of the majority, are chiefly felt through the changes that occur during the year. Now, we have seen that the line of mean annual temperature of England departs in a very marked manner from coincidence with a latitude-parallel; but we shall find the lines indicating the extreme temperatures of the year much more irregular; and the peculiarity of climate, which their conformation illustrates, much more important.

In Fig. 1 the *isochimenal*, or the line of equal winter heat, through London, is indicated by a strongly marked closed curve. Its form is remarkable. It passes nearly in a north and south direction, along the length of England and Scotland, approaches suspiciously near to Iceland, but turns sharply southwards and travels across the Atlantic in a direction which brings it to the American continent near Washington; still approaching the tropics, it travels through the northern parts of Texas, where it reaches its greatest southerly range. Passing gradually northwards to the neighbourhood of the Aleutian Islands, it thence trends southwards again, passes through the Corea, traverses the Asiatic continent nearly on the latitude-parallel of Nankin; thence travelling slightly northwards, it crosses the southern part of the Caspian Sea, the Black Sea, the north of Turkey, and passes through Venice and Paris to London. On the continents the isochimenal falls outside (that is, south of) the annual isotherm, while on the oceans the reverse holds. The projection of the isochimenal thus appears as an irregular oval, whose greatest length lies on the continents.

We see here, again, the indication of a tendency to form two curves, and thus of the presence of two poles of extreme winter cold in the northern hemisphere. The isochimenals of greatest cold hitherto traced in the two continents, are shown by two broken curves in Fig. 1. The cold of the Asiatic curve is very much greater than that of the American, the former curve marking a winter cold of —40° Fahrenheit (72° below freezing), the latter a winter cold of —26° 5′, only—if one may apply such an adverb to a cold of 58° 5′ below freezing. Professor Nichol remarks that, "if a polar projection were made of these regions for January, it would be found that the two coldest spaces of these continents form a continuous band passing across the pole of the earth." I cannot but think that this is a mistake. I believe that if the isotherms traced, in

part, in Fig. 1 could be completed, they would be found to form two ovals. The American oval would enclose the American pole of mean temperature, but very eccentrically, showing that the pole of extreme winter temperature lay westwards and southwards, probably near Victoria Land. The Asiatic oval would not probably enclose the Asiatic pole of mean temperature; and the position indicated for the Asiatic pole of extreme winter cold lies on or near the Arctic circle, where it is crossed by the river Lena. At the true pole of the earth the extreme winter cold is probably not nearly so intense as the cold at either of the points here indicated.

From the direction of the isochimenal through London, it is evident that the Eastern Counties and Kent experience the coldest winters of all places in the British Isles, while Cornwall and the south-westerly parts of Ireland enjoy the mildest winter climates. In fact, winter in Cornwall is not more severe than in Constantinople; and in south-west Ireland the winter is still milder, approaching, in this respect, to the winter climate of Teheran.

The contrast, when we turn to the *isotheral* of London, is remarkable. Instead of travelling nearly northwards, this curve passes in a south-westerly direction, reaching its greatest southerly range in the central part of the Atlantic Ocean; thence it travels with a northerly sweep through Nova Scotia and Canada, till it reaches its greatest northerly range near the Rocky Mountains.* Thence it turns sharply southwards, crosses Vancouver's Island, sweeps nearly to latitude 45° in the central part of the Pacific, whence passing slightly northwards it crosses the southern part of Saghalien Island. Here it turns sharply northwards, crosses that very district of Siberia which, in Fig. 1, is occupied by the isochimenal of intensest winter cold, traverses Siberia, and passes near St. Petersburg, through Berlin and Amsterdam to London.

The relations thus presented by the isotheral of London are precisely the reverse of those exhibited by the isochimenal. The isotheral forms a closed, irregular oval, whose greatest length lies on the two oceans. Here it falls outside the line of mean annual heat, while on the continent it falls far within this line.

In another respect the isotheral presents a noteworthy contrast to the isochimenal. While the latter encloses an area largely exceeding the area enclosed by the mean annual line, the isotheral encloses an area noticeably smaller.†

* It is noteworthy that the minimum distance of the isotheral from the North Pole here attained, is exactly equal to the minimum distance of the isochimenal from the equator.

† Here an important advantage of the isographic projection is exhibited. The relation pointed out is altogether obliterated in Mercator's projection, and could only be roughly inferred from any but an isographic projection.

A tendency to break up into two curves is exhibited in the isotheral, even more markedly than in the two other curves. But singularly enough, here, where one would expect more certain information of the existence of poles of cold, since so much more of the northern hemisphere can be traversed in summer than in winter, we have no satisfactory evidence. In fact, the irregular curve marked in near the pole in Fig. 2 is the most northerly isotheral yet determined. The temperature corresponding to this isotheral is 36° Fahrenheit, or four degrees above freezing. From a consideration of the form-variations of the isotherals as they travel northwards, I have been led to the opinion that there exist *three* poles of summer cold, and that these fall not very far from the positions indicated by the small dark circles in Fig. 2.

From the direction of the isotheral line through London, it is evident that along the southern coast of England the heat of summer is greater than in any other part of the British Isles. On the other hand, the northern parts of Scotland, which we have seen, enjoy a winter climate fully as warm as that of London, have a much cooler summer climate. The south-western parts of Ireland exhibit a change even more remarkable. For whereas the winter climate in these parts is the same as that of Persia, the summer climate is the same as that of the very portion of Siberia in which (most probably) the greatest cold ever observable in our northern hemisphere is experienced in winter. The summer of the Orkney Islands, again, is no warmer than that of the southern parts of Iceland.

It appears, then, that the inhabitants of England enjoy three notable advantages as respects climate. First, a higher mean annual temperature than that of any other country so far from the equator; secondly, a moderate degree of cold in winter; and, lastly, a moderate degree of heat in summer. The last two advantages resolve themselves into one, viz., small range of temperature throughout the year. Our range of climate is from about 36° in winter to 62½° in summer, or in all, 26½° Fahrenheit. Compare with this the climate of the country near Lake Winnipeg, with a winter cold of 4° below zero, and a summer heat scarcely inferior to that of London; so that the range of climate is no less than 65°. Yet more remarkable is the variation of climate in parts of Siberia, near Yakutsk; here the range is from —40° in winter to 62° in summer—a variation of 102°, or four times the variation of our London climate. Other parts of the British Isles have, however, a yet smaller range even than that of London. Thus in the south-western parts of Ireland, and in the Orkney Isles, the variation is less than 19°.

Nor is it difficult to assign sufficient reasons for the mild-

ness of the British climate—for our warm winters and cold summers. It will appear, on examination, that nearly all the constant causes affecting the temperature of a climate operate to raise the mean temperature of our year, while, of variable causes those which tend to generate increased heat operate in winter, while those which have a contrary effect operate in summer.

Humboldt enumerates among the causes tending to exalt temperature, the following non-variables :—The vicinity of a west coast in the northern temperate zone; the configuration of a country cut up by numerous deep bays and far-penetrating arms of the sea; the right position of a portion of the dry land, *i.e.*, its relation to an ocean free of ice, extending beyond the polar circle, or to a continent of considerable extent which lies beyond the same meridional lines under the equator, or at least in part within the tropics; the rarity of swamps which continue covered with ice through the spring, or even into summer; the absence of forests on a dry, sandy soil; and the neighbourhood of an ocean-current of a higher temperature than that of the surrounding sea.

All these causes, it will be observed—except the neighbourhood of a tropical continent on the same meridian—tend to increase the mean heat of the climate in England. The great Gulf Stream probably exercises a more important influence than any of the others. Its position is indicated in Figs. 1 and 2. Humboldt attaches a high importance to the presence of a tropical continent on the same meridian; and he considers that the climate of Europe is warmer than that of Asia, because Africa, with its extensive heat-radiating deserts, lies to the south of Europe, while the Indian Ocean lies to the south of Asia. There are objections, however, to the reasoning he adopts. In the first place, if the heat-radiating power of a continent really influenced the country lying to the north, it should tend to lower rather than raise the temperature, for the ascending currents of air would strengthen the currents of colder air pouring in from the north, and these currents—on Humboldt's assumption that the country directly to the north is that affected—would lower the mean annual temperature. It would only be exceptionally that the warmer returning currents would descend, and thus exalt the temperature. It seems clear, however, that Asia is the continent chiefly affected by the heat-radiating power of Africa; since the cold currents from the north travel eastwards, while the warm return-current has a westerly motion. We should thus attribute the milder climate of Europe rather to the influence of the tropical parts of the Atlantic Ocean, than to the cause assigned by Humboldt, and we should invert the effects he

attributes to oceans and continents respectively. With this change—somewhat a bold one, I confess *—we may say that all the non-variable causes tending to exalt temperature operate in England's favour.

The constant causes tending to lower temperature are simply the converse of those above considered.

Of variable causes increasing temperature, the principal are a serene sky in summer, and a cloudy sky in winter. It may appear, at first sight, paradoxical to assign opposite effects to a cloudy sky. It must be remembered, however, that clouds considered with reference to temperature, have two functions: they partially prevent the access of heat to the earth, and they partially prevent the escape of heat from the earth. Now, in summer the first-named influence is more important than the second: the days are longer than the nights; that is, the earth is receiving heat during the greater part of the time in summer. A cause, therefore, which affects the receipt of heat is more important than a cause affecting the escape of heat. On the other hand, in winter, the nights are shorter than the days, and the influence of clouds in preventing the escape of heat becomes more important than their effect on the receipt of heat.† In fact we may compare the influence of clouds to the effects of certain kinds of clothing; flannel, for instance, is as suitable an article of dress for the cricketer as for the skater.

Now the climate of England is remarkably humid both in winter and summer. And this humidity is shown, not so much by the quantity of rain which falls, as by the frequent presence of large quantities of aqueous vapour in the atmosphere. Skies, even, which we in England consider clear, are overcast compared with the deep-blue skies of France or Italy. What the influence of these humid palls may be "on the outflow of moral sentiments" which Humboldt considered to be so favourably influenced by transparent skies, I shall not here pause to inquire. It is clear, however, that the influence of our cloudy skies tends to modify the severity both of our winter and our summer seasons; and these benefits are so great that we may

* Not unsupported, however, by good authority. Thus Professor Nichol, speaking of the climate of Europe, writes: "The air that rises in Africa blows rather over Asia than Europe. The cradle of our winds is not in Sahara but in America." Again, Kaemtz notices, that if the effects of oceans and continents were those assigned by Humboldt, we should find in the western parts of America a colder climate than in the eastern parts; the reverse, however is the case.

† Gilbert White noticed long ago—apparently without understanding—the influence of a clouded sky on the temperature. "We have often observed," he says, "that cold seems to descend from above; for, when a thermometer hangs abroad on a frosty night, the intervention of a cloud shall immediately raise the mercury ten degrees; and a clear sky shall again compel it to descend to its former gauge."

cheerfully accept them as more than a counterpoise for hypothetical injurious effects on "the outflow of our moral sentiments," whatever that may be.

I proceed to consider the actual variations presented in the course of a year in England. As some selection must be made, I shall select the series of observations which have been made at Greenwich during the present century. It will be gathered from the preceding pages that the range of temperature at Greenwich is at least not less than the average range of the British Isles. Greenwich, also, from its neighbourhood to London, and from the number and accuracy of the observations made there, is obviously the best selection that could be made. It must not be forgotten, however, that the climate of Greenwich is not the climate of the British Isles, and that careful observations made in other places have sufficiently indicated the existence of *local* peculiarities, which, therefore, it may fairly be assumed, characterize also the Greenwich indications.

In Fig. 3 the annual variations of mean diurnal temperature are represented graphically. The figure was formed in the following manner:—A rectangle having been drawn, each of the longer sides was divided into 365 parts, and a series of parallel lines joining every tenth of these divisions was pencilled in. The spaces separating these lines represented successive intervals of ten days throughout the year. The shorter sides were divided into thirty-three parts and parallel lines drawn, joining the points of division. Of these longer parallels the lowest was taken to represent a temperature of 32° Fahrenheit (*i.e.*, the freezing point) and the others in order, successive degrees of heat up to 65°. Then, from the Greenwich tables, which have been formed from the observations of forty-three years, the temperature of each day was marked in, at its proper level and at its proper distance from either end of the rectangle. Thus 365 points were marked in, and these being joined by a connected line, presented the curve exhibited in Fig. 3. The lines bounding the months, and the lines indicating 35°, 40°, etc., Fahrenheit, were then inked in and the figure completed.

The resulting curve is remarkable in many respects. In the first place, it was to have been expected that a curve representing the average of so many years of observation would be uniform; that is, would only exhibit variations in its rate of rise and fall, not such a multiplicity of alternations as are observed in Fig. 3. And this irregularity will appear the more remarkable when it is remembered that the temperatures used as the Greenwich means are not the true average temperatures. They were obtained by constructing a curve from the

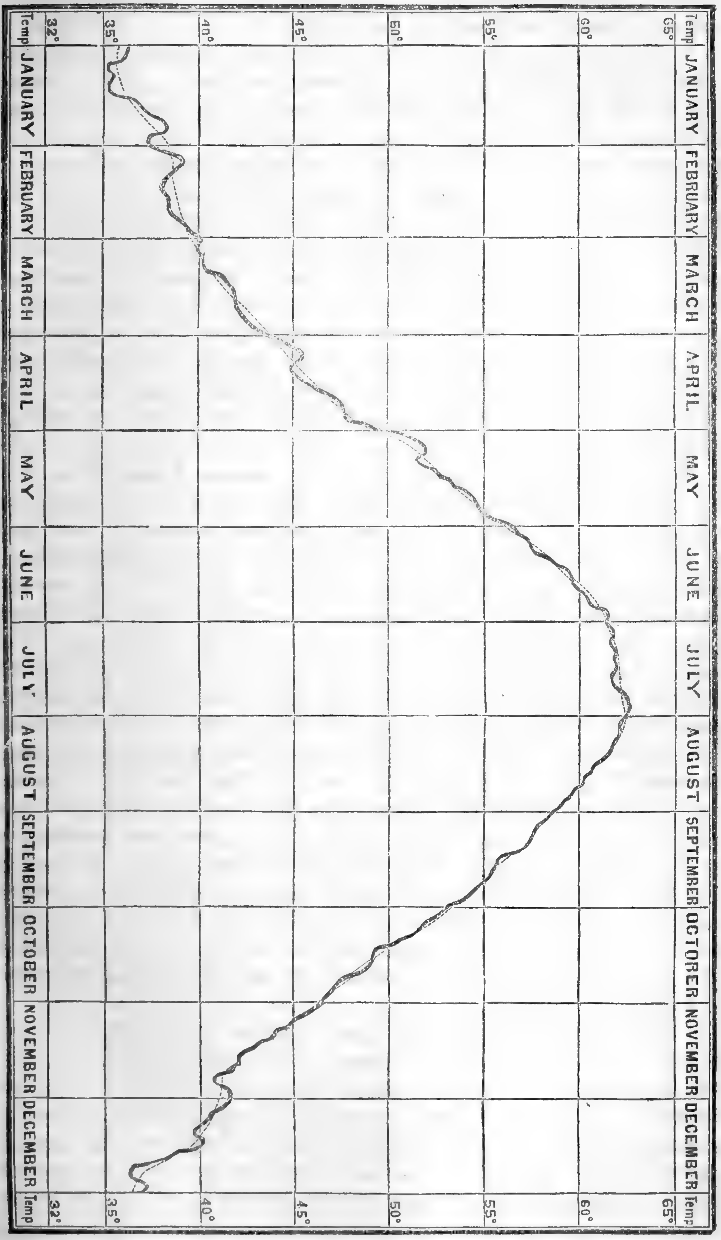


Fig. 3.—Annual Variation of Mean Diurnal Temperature at Greenwich.

true averages, and taking a curved line (the curve of Fig. 3, in fact) in such a way as to take off the most marked irregularities of the true curve of averages; or, to use the words of the meteorologist who constructed the Greenwich table of means, Mr. Glaisher, a curved line was drawn which passed through or near all the points determining the true curve of averages, "and in such a way that the area of the space above the adopted line of mean temperature was equal to that below the line." Despite this process, the curve exhibits no less than fourteen distinctly marked maxima of elevation, and a much larger number of variations of flexure. The sudden variations of temperature at the beginning of February, early in April, and early in May are very remarkable; they have their counterparts in the three variations which take place between the latter part of November and the end of the year, only these occur in much more rapid succession. The nature of the curve between June and August is also remarkable, as are the three convexities which are exhibited in the September, October, and November portions of the curve.

If we follow our leading meteorologists in taking the curve of Fig. 3 as representing the true annual climate of London, how are we to assign physical causes for the remarkable variations above indicated? Not easily, I take it. It were, indeed, as easy as inviting to speculate on cosmical causes;—to follow Ertel, for instance, in assigning effects to those zones of meteorites which are known to intersect the earth's orbit, and others which may fairly be assumed to fall within or without that orbit. It may be, perhaps, that the fifty-two recognized shooting-star periods have, some of them, their counterparts in heat-changes; but certainly the time has not yet come to pronounce a consistent theory of such effects. The evidence afforded by the Greenwich curve on this point is unsatisfactory to say the least. The elevation at the beginning of January, and the marked irregularity in February, correspond to Ertel's views; so also the fact that large aerolites have frequently fallen in the first week in April, about the 20th of April, about the 18th of May, early in August,* about the 19th of October, and early in December, *seems* to correspond to elevations in the curve; while the depression opposite the 12th of May, might be referred to the intervention of the zone of meteors, which causes the now celebrated November shower. But the negative evidence is almost equally strong. Where, for instance, is the elevation which one would expect, on Ertel's theory, in November? Also, if the cause of the observed irregularities were that suggested by Ertel, the curves for other

* Reference is not made here to the August shooting-star shower, which takes place a week later than the epoch alluded to.

countries in the northern hemisphere should exhibit similar irregularities on corresponding dates, which does not appear to be the case. In fact, if there really exist effects due to cosmical causes, these are not likely to be educed from observations of the variation of mean diurnal temperature, since it is clear that a cause of variation due to objects external to the earth could affect only the temperature of certain hours of one day, or of several days. A cluster of meteors between the earth and the sun might diminish the mid-day heat; one external to the earth's orbit might increase the nocturnal temperature; and though in either case the mean diurnal temperature would be affected, yet it is obvious that the effect would be masked in taking the mean, or even that two or more opposing influences might cancel each other. If it could be shown that the curve for mid-day, or for midnight heat corresponded to the curve of mean heat, Ertel's theory would be overthrown at once; since, for its support it is necessary to show that depressions in the mean curve are due to mid-day loss of heat, and elevations to midnight gain of heat.

There are, however, terrestrial causes to which the irregularities of our curve (which irregularities, be it remembered, represent *regularly recurring irregularities* of heat) may be ascribed. For instance, there can be no doubt that our climate is considerably affected by the changes which take place in the Polar seas; and it may not unfairly be assumed that the processes by which different regions of Polar ice are successively set adrift (to be carried southward by the strong under-current known to exist in the northern Atlantic Ocean), take place at epochs which recur with tolerable regularity. And it may be that the irregularity of the rising, as compared with the falling half of the heat-curve is due to this cause; since the breaking-up of ice-fields, and their rapid transport southwards would clearly produce sudden changes, having no counterpart in the effects due to the gradual process of freezing.*

It may well be, however, that the observations of forty-three years are not sufficient to afford the true mean diurnal temperature for a climate so variable as ours. Indeed, if the curves given by Kaemtz for continental climates be as accurately indicative of observed changes, as that of Fig. 3, we must either accept such an hypothesis, or else assume that the English climate is marked by regularly recurring variations altogether wanting in continental climates; and it is to be noted that the regular recurrence of changes is a peculiarity wholly distinct from variability of climate, properly so termed, and seems, even, inconsistent with such a characteristic. It

* Icebergs have been seen travelling southwards against a strong northward surface-current, and even forcing their way through field-ice in so travelling.

may happen, therefore, that the observations of the next thirty or forty years will afford a curve of different figure; and that by comparing the observations of the eighty or ninety years, which would then be available, many, or all of the irregularities exhibited in Fig. 3 might be removed. In this case we might expect our climate-curve to assume the form indicated by the light line taken through the irregularities of Fig. 3. It will be observed that this modified curve exhibits but one maximum and one minimum. It is not wholly free, however, from variations of flexure. It presents, indeed, six well-marked convexities, and as many concavities; in other words, no less than twelve points of inflexion. The most remarkable irregularity of this sort, is that exhibited near the end of November; and it is noteworthy that this irregularity is presented by continental climate-curves also. It has been ascribed by Ertel to the effect of the meteor-zone, which causes the November shower. But as it is exhibited by the curves of *horary* as well as of *diurnal* means, while the meteor-zone cannot by any possibility affect the temperature of the earth's *following hemisphere,* and as, further, it does not correspond to the true date of the shower, this view may be looked upon as doubtful. The August curve occurring near the maximum elevation—where slow change was to be expected, is also well worthy of notice; as are the January and May flexures.

It will be noticed that nothing has been said of extreme heat or cold occasionally experienced in England. As such visits generally last but for a short time, their effects are not very injurious, save on the very weak, the aged, or the invalid. Corresponding to the passage of an intense heat-wave or cold-wave, there invariably occurs a sudden rise in the mortality-returns; but almost as invariably the rise is followed by a nearly equivalent, but less sudden, fall; showing, conclusively, that many of the deaths which marked the epoch of severest weather occurred a few weeks only before their natural time.

The weather during a part of the late winter was somewhat severer than our average English winter-weather. The thermometer, however, at no time descended below zero, as it did on January 3, 1854; and the diurnal mean did not descend at any time so low as 10° 7′, as it did on January 20, 1838. There is no foundation for the opinion, sometimes expressed, that our winter-weather is changing. An examination of the columns in the Greenwich meteorological tables, show that the successive recurrence of several mild winters is not peculiar to the last decade or two. The observations of Gilbert White, imperfect as they are compared with modern observations, point the same way.

Among severe, but short intervals of cold weather, may be

noted that which occurred in January, 1768. The frost was so intense, says Gilbert White, "that horses fell sick with an epidemic distemper which injured the winds of many and killed some; meat was so hard frozen that it could not be spitted, nor secured but in cellars; and bays, laurustines, and laurels were killed."

White's account of the summer of 1783 will fitly close our sketch of British weather-changes. "This summer," he says, "was an amazing and portentous one, and full of horrible phenomena; for, besides the alarming meteors and tremendous thunder-storms that affrighted and distressed the different counties of this kingdom, the peculiar haze, or smoky fog, that prevailed for many weeks in this island, and in every part of Europe, and even beyond its limits, was a most extraordinary appearance, unlike anything known within the memory of man. By my journal, I find that I had noticed this strange occurrence from June 23rd to July 20th, inclusive, during which period the wind varied to every quarter, without making any alteration in the air. The sun at noon looked as blank and ferruginous as a clouded moon, and shed a rust-coloured ferruginous light on the ground and floors of rooms, but was particularly lurid and blood-coloured at rising and setting. All the time the heat was so intense that butchers' meat could hardly be eaten the day after it was killed; and the flies swarmed so in the lanes and hedges, that they rendered the horses half frantic, and riding irksome. The country people began to look with a superstitious awe at the red, lowring aspect of the sun. Milton's noble simile, in his first book of 'Paradise Lost,' frequently occurred to my mind; and it is, indeed, particularly applicable, because towards the end, it alludes to a superstitious kind of dread, with which the minds of men are always impressed by such strange and unusual phenomena:—

> 'As when the sun new risen,
> Looks through the horizontal, misty air,
> Shorn of his beams; or, from behind the moon,
> In dim eclipse, disastrous twilight sheds
> On half the nations, and with fear of change
> Perplexes monarchs.' "

THE VEGETABLE SHEEP OF NEW ZEALAND.

BY JOHN R. JACKSON.

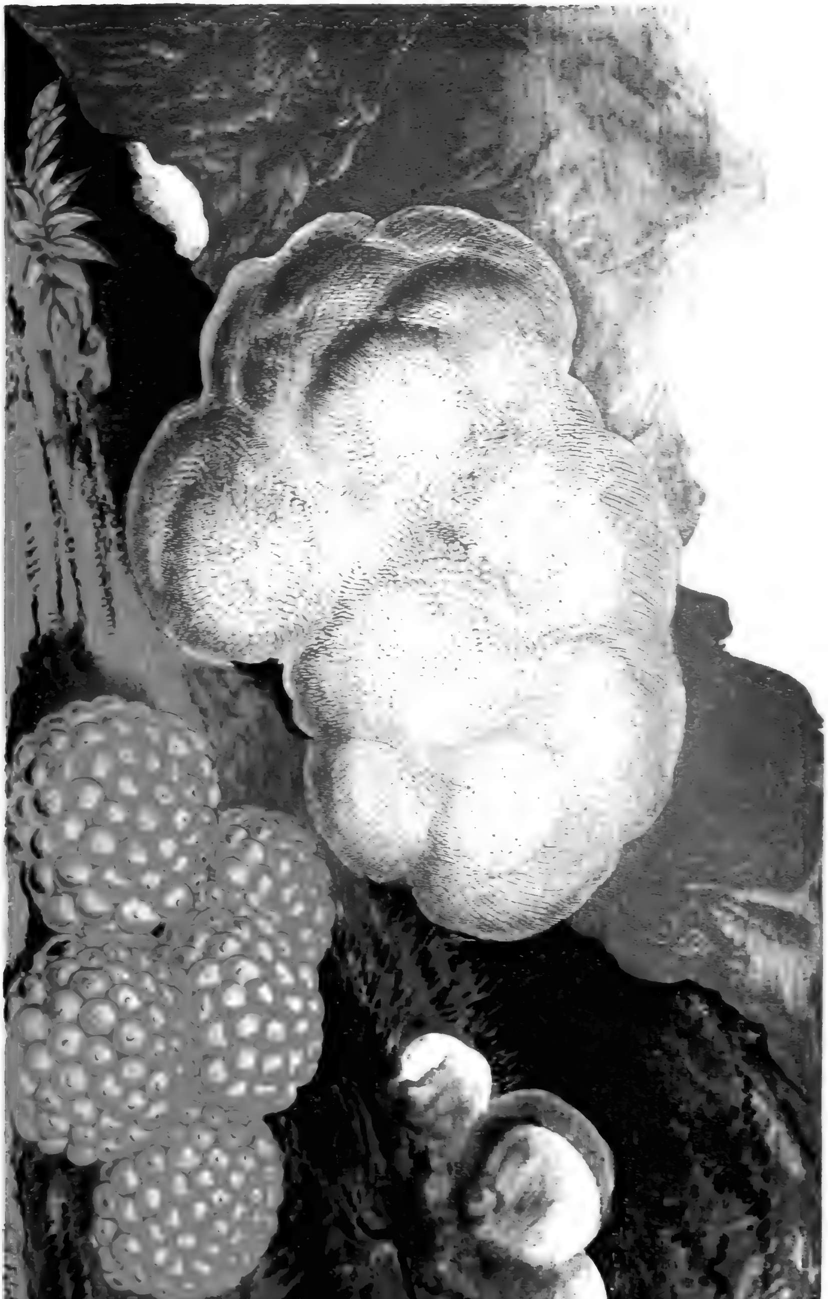
Curator of the Museum, Royal Gardens, Kew.

(*With a Coloured Plate.*)

It may, perhaps, be thought from our heading that we are about to note the discovery of a new phenomenon in the animal kingdom; on the contrary, the sheep of which we are about to speak is a true plant, and belongs to the same family as our common daisy. This family—the *Compositæ*—is one of the most extensive and widely diffused in the whole vegetable kingdom. It numbers some 1,000 species, and no part of the globe is without some of its representatives. Lindley says that the *Composite* order alone comprehends at the present day more species than Linnæus knew as belonging to the whole vegetable kingdom. In so large an order, with such a wide geographical distribution, we might be naturally led to expect a great variety of forms, which indeed there are, for while the bulk of the *Composites* with us are small annuals, in other countries they are frequently seen as shrubs, or even trees. These arborescent forms seem to increase as we approach the equator. Most of the *Compositæ* in the island of St. Helena attain to a large size. The Tasmanian Dogwood, *Bedfordia salicina*, Dec., grows to a height of twenty-five feet, and furnishes a very hard word. The muskwood, also, *Eurybia argophylla*, Cass., is a tree about thirty feet high, and abundant throughout the island in damp localities. This latter tree is a near ally to our common aster, or Michaelmas Daisy. Though so variable in form and general appearance, the minute structure of the *Composites* are particularly alike, so that an observer cannot fail to recognize the affinities of the various plants. New Zealand is the head-quarters of the most singular forms of *Compositæ*; such forms, indeed, as are there found would at first puzzle many to determine what they were, or even, indeed, if they were a vegetable at all.

Peculiar-looking patches are to be seen upon the sides and tops of the mountains, which in the distance look like so many sheep, and even upon nearing them their shaggy appearance help rather to confirm the first impression than to dispel such a notion. Upon a somewhat closer examination, however, we should possibly be ready to believe that these hemispherical masses are those of a gigantic moss. These tufts are, in reality, masses of plants belonging to the genus *Raoulia*, one species of which is known to the New Zealand settlers as the

THE VEGETABLE SHEEP OF NEW ZEALAND.



"vegetable sheep." The shepherds themselves are often deceived by them when calling in their sheep from the mountains. Our plate will give an idea of the general appearance of the plant, to the right of which is represented another singular plant, *Haastia pulvinaris*, of which we shall also give a brief description. *Raoulia* is very nearly allied to *Gnaphalium* and *Helichrysum*, to which latter genus the everlasting flower, or *immortelle* of the French, belongs. The principal difference exists in the narrow receptacle of the flower-heads of *Raoulia* compared with that of the other two genera. The singular habit and general appearance of the plant are also prominent distinguishing characters. Dr. Hooker says it is "a genus founded on habit more than on any good characters that can separate it from *Gnaphalium*, section *Helichrysum*. Its herbaceous habit distinguishes it from *Ozothamnus*. It contains two natural and most distinct sections, of which one, containing *R. subulata, eximia, grandiflora, mammilaris*, and *bryoides* has a convex, often hispid, receptacle; achenes with very long, silky hairs, a thickened areole at their base, and stout, rigid, opaque, pappus hairs, thickened at the tip. These probably constitute a good genus, to which the name *Raoulia* may be retained; the others may, perhaps, fall into *Gnaphalium* or *Helichrysum*; but until all the *Gnaphalioid Compositæ* are worked up, it is impossible to settle the limits of the genera."

Though there is a difference in the habits of the two genera, *Gnaphalium* and *Raoulia*, the woolly appearance occurs in both, for the leaves, stems, and flowers of many species of the former genus are completely covered with a greyish, soft, velvety down. Twelve species of *Raoulia* have been discovered in New Zealand, where the plants are alone found. These species have all been named and described by Dr. Hooker, as well as the genus itself, which is in honour of M. Raoul, a surgeon in the French navy, who has paid some attention to New Zealand plants. It may be interesting to our readers if we give a description of each of the species, abridged from the *Handbook of the New Zealand Flora*.

1. *Raoulia Australis*, Hf. A small, moss-like, densely-tufted plant, stems one to two inches high, branches slender, leaves minute, laxly or densely imbricate, half an inch long, covered with silky, appressed wool. Heads one-eighth of an inch long, outermost scales spathulate, inner linear, shining yellow or pale brown, not dark at tips, nor white and radiating; florets about twelve, outer few, pappus hairs excessively slender, subpilose, not thickened at the tips. Achene glabrous. This species is found on lofty, rocky hills in the Northern Island, on the Nelson Mountains, Otago, and other places in the Middle Island.

2. *R. tenuicaulis*, Hf. Stems generally slender, loosely tufted, prostrate, creeping, one to ten inches long, with ascending branches. Leaves loosely imbricating, spreading and recurved, one-twelfth of an inch long, grey, with appressed silvery tomentum. Heads very similar to those of *R. Australis*, but involucral scales, with brown acute tips. Found in the gravelly beds of rivers in Northern Island, and also at Kowai River, Middle Island, at an altitude of one to two thousand feet.

3. *R. Haastii*, Hf. A small, densely tufted, nearly glabrous plant, stems rather stout, prostrate, branches one inch high. Leaves densely imbricate, one-sixteenth of an inch long, broadly sheathing, broadly ovate, coriaceous, obscurely woolly or silky. Flower-heads similar to those of *R. Australis*, but narrower, with six to eight florets; involucral scales obtuse, not brown, nor with a white radiating tip. Found in gravelly terraces at Kowai River and Waiauna Valley.

4. *R. Munroi*, Hf. Stems slender, creeping, with very long, wiry, filiform rootlets. Branches slender, ascending, one to two inches high. Leaves laxly imbricate, one-eighth to one-sixth of an inch long, linear, obtuse, uniformly clothed with grey, silky tomentum. Heads narrow, one-sixth of an inch long; involucral scales glabrous, linear, green, with rather dilated, scarious brown tips; florets about twelve; pappus as in *R. Australis*. The wiry stems and very long filiform rootlets are prominent characters, as are the uniformly grey, silky, linear leaves, and narrow heads, with brown-tipped, involucral scales. The plant has been found in Waihopai Valley and Canterbury Plains.

5. *R. subulata*, Hf. A small, very densely tufted, rigid, moss-like species, quite glabrous throughout, blackish when dry, stems stoutish, branches half an inch high. Leaves most densely imbricate, patent or suberect, rigid, subulate, acuminate. Heads large for the size of the plant, one-sixth of an inch in diameter; involucral scales linear, oblong, scarious, shorter than the leaves; receptacle convex, hispid: florets of circumference in several rows, pappus of rigid, scabrid hairs, rather thickened at the tips. Achene silky. A remarkable and very small species, differing much from the foregoing in the pappus, hispid receptacle, and foliage. This species is found on the Nelson and Otago Mountains, at an altitude of from five to six thousand feet.

6. *R. eximia*, Hf. The vegetable sheep. A small, most densely-tufted, hard little plant, forming large woolly balls on the mountains, enveloped in soft, velvety, white tomentum; branches very short, with the leaves forming cylindric or mammilliform knobs, one quarter of an inch in diameter;

leaves most densely compacted, wholly hidden amongst woolly hairs, imbricated all round in many series, one-eighth of an inch long, membranous, broadly linear or obovate oblong, rounded at the tip, bearing at the back, above the middle, a dense thick pencil of white velvety hairs, these bundles of hairs, meeting beyond the leaves, envelope the whole. Heads minute, sunk amongst the upper leaves, involucral scales about ten, linear, with subulate or obtuse tips, and a tuft of hairs on the back above the middle: receptacle convex, naked; florets about ten. Pappus of few rigid hairs, thickened upwards. Achene with a thickened areole at the base, silky, with very long hairs; very nearly allied to *R. mammilaris.* Found in the Middle Island, at Ribband Wood Range, Mount Arrowsmith, and Dobson, at an elevation of 5500 to 6000 feet.

7. *R. Hectori,* Hf. Most densely tufted, one to two inches high; branchlets erect, densely leafy, silvery at the tips. Leaves closely imbricate one-twelfth of an inch long, broadly ovate, obtuse, coriaceous, upper half covered with appressed silvery, shining tomentum; back grooved longitudinally when dry. Heads small, sunk amongst the uppermost leaves; involucral scales scarious, linear-oblong, obtuse, yellowish, glabrous, receptacle convex, pilose; florets about twenty. Pappus of few, rigid, scabrous hairs, thickened upwards. A very distinct species, resembling in habit some states of *R. Australis.* Found in the lake district of Otago in dry, subalpine places.

8. *R. glabra,* Hf. Stems elongate, slender, prostrate, branching, two to ten inches long; branches ascending. Leaves laxly imbricate, spreading, hardly ever recurved, one-sixth of an inch long, linear, or linear-oblong, acute or obtuse, glabrous or nearly so, one nerved, green. Heads rather large, one-fourth to one-third of an inch in diameter; outer involucral scales leaf-like, inner linear, with short, white, radiating tips; florets numerous, outer in two series. Pappus of numerous soft, white, slender hairs, as in *R. Australis.* Achene covered with down. Found in the Nelson Mountains, Mount Cook, and Otago Mountains.

9. *R. subsericea,* Hf. Very similar in most respects to *R. glabra,* and perhaps an alpine variety of that, but a much more densely-tufted plant, with very short stems and branches; closely imbricated, linear-oblong leaves; glabrous or covered loosely with silvery tomentum; green or silvery white. Heads similar, but larger. Found in many parts of Middle Island, up to an elevation of from 3000 to 4000 feet.

10. *R. grandiflora,* Hf. A very short, erect, densely-tufted species, with very long, wiry, thread-like roots; stems one inch high, densely leafy, with the leaves on as thick as the little finger. Leaves imbricating all round the stem one-sixth

to one-fourth of an inch long, rigid, shining, with white, silky hairs, cottony; at the base, striate. Heads large, one-third to two-thirds of an inch in diameter; involucral scales one to two series, long, white, linear, spreading, one-fourth of an inch long; receptacle convex, hispid. Pappus hairs few, rigid, swollen towards the tip. Achene silky. Found in the Northern and Middle Islands, at the top of Gordon's Nob, Mounts Cook, Darwin, and Torlesse, at an elevation of from 5000 to 7000 feet, as well as on other mountains, widely spreading, and forming perfect carpets.

11. *R. mammilaris*, Hf. Like *R. eximia* forming large, hard, hemispherical balls and patches on the ground, sometimes eight feet long and three feet high; branches very short, thick, with the leaves on, forming cylindric or mammilary knobs one-fourth of an inch in diameter. Leaves most densely compacted, imbricated in many series, spreading, one-tenth to one-twelfth of an inch long, obovate cuneate, or spathulate, cottony below, with a dense brush of velvety hairs on both surfaces beyond the middle, which does not exceed the tip of the leaf. Heads very small, one-sixth of an inch in diameter, about ten flowered; inner involucral scales with short, white, acute, radiating tips; receptacle, convex, naked. Pappus of few rigid hairs, thickened at the tips. Very similar in many respects to *R. eximia*, and closely allied to it; but the leaves are smaller, with the velvety hairs not so long as to hide them, more cottony and obovate, and the inner involucral scales are distinctly rayed. Achene with a swollen areole at base, and long, white, silky hairs. Found on hard soil and rocky places on Mount Torlesse, at an altitude of 3000 to 5000 feet.

12. *R. bryoides*, Hf. Forms hard, dense, convex, hoary patches, with an even surface; branches one-half to one and a half inches long, densely compacted, with the leaves on cylindric. Leaves most densely imbricate all round the branches; erecto-patent one-twelfth to one-tenth of an inch long, broad, linear, rather dilated at the obtuse tip, membranous, coriaceous; margins cottony, glabrous below the upper one-third, above that covered with appressed silky wool, one nerved. Heads one-fourth of an inch in diameter, about twelve flowered; involucral scales with white, subacute, radiating tips; pappus hairs few, rigid, with thickened tips. Achene with very long white hairs, and a thickened areole at the base. Found at top of Gordon's Nob, in the Clarence and Wairau Valleys, at an elevation of 3000 to 4000 feet.

From the foregoing descriptions it will be seen that though the whole of the species agree in many points of detail, the general appearance of some are widely different from that of

others. *R. eximia* is certainly the most peculiar, forming large masses like cushions, often two feet high and three feet in diameter, and this species is known to the natives as the vegetable sheep. A fine tuft of this plant is in the Museum, Kew. The plants indeed, on the whole, have more the appearance of mosses than exogens, the tomentum of the leaves of many of the species being developed to such an extent as to completely envelope them, and almost to conceal the star-like flower-heads, which are seated at the apex of each short twig.

R. grandiflora, as its name indicates, is a very beautiful little plant when in flower; the involucral scales, which are white, might readily be mistaken for the ray florets; but these, like the disk florets, are tubular. The pappus hairs, seen under a microscope, are rough, the edges being apparently clothed with small prolongations, but the thickness and rigidity of these vary much in the different species.

Nearly allied to *Raoulia* is the genus *Haastia,* named by Dr. Hooker in honour of Dr. Julius Haast. The plants have a very similar habit to *Raoulia,* forming balls or cushions on the lofty mountains. These species are mentioned as growing in New Zealand, but *Haastia pulvinaris,* Hf., is the most remarkable; indeed, Dr. Hooker says that it is one of the most remarkable plants in the islands. Masses occur quite three feet in diameter, covered with fulvous wool. The leaves are crowded, broad, but completely hidden in the wool. This is a very close-growing plant; indeed, the patches of it are too dense even to admit of the finger being thrust between the branches. It has been found on mountains at an elevation of 5800 feet. The tufts represented in the plate are those of young plants.

Though singular and interesting to the botanist, these plants are of no value economically, but, on the contrary, as we have shown, certain species of them are a plague to the shepherds, inasmuch as they give them much trouble and annoyance to discern between an animal sheep and a vegetable sheep.

Leaves and Flowers of the Vegetable Sheep.

BY HENRY J. SLACK, F.G.S., HON. SEC. R.M.S.

Through the kindness of Mr. Jackson, I have been able to examine the leaves and flowers of the "vegetable sheep" (*Raoulia eximia*) as they exist in the Kew specimen. When I saw that specimen in the summer of last year, I was struck by an appear-

ance of several bodies projecting from the general surface like minute outgrowths. On microscopic examination they appeared to consist of flowers in a dry state, surmounting immature achenes (or *seeds*), at the base of which were fleshy rings, apparently in a living state. The appearance of these flowers is shown in the annexed woodcut, which is reduced from a drawing made on a larger scale. It will be seen that there are two kinds of hairs, one simple and the other highly complex. The former spring from the annular disc or fleshy ring at the base of the achene, and from the body of the achene, while the latter arise from the flower which is above it. The dark mark shows the point at which the flower and achene divide. The composite hairs consist of a number of small tubes delicately white, and with slightly wrinkled surfaces. They require powers of from 100 and upwards for their effective display. The number of the tubes in these compound hairs varies considerably in different specimens. In one I counted sixteen tubes in the central part. The tubes at the sides throw out projections with pointed tips, and another tube usually joins the diverging tube, and continues a straight course. On one of the flowers, which was slightly broken so as to show its interior, I noticed small pale-yellow pollen grains, which show no inclination to shrivel up.

N. S.

COROLLA AND ACHENE.

The most curious fact is, that the annular discs or fleshy rings at the base of the achenes contain pale, yellow-green chlorophyll, apparently in a living state, although the Kew specimen plant looks quite dry, and has been a year or two in a glass-case in a warm room. My specimens, which have been mounted under their glass covers for many months, still look plump and fresh, and it would appear that the plant is so constructed as to bear a prolonged drought without losing its vitality by excess of evaporation—at least, that is the conclusion to which I have been led by examining these flowers, and some sections which I made of the stem.

The leaves are very curious microscopic objects. In the dry state they, like the flower, are brown. They consist of

elongated cells, surrounded in some cases by smaller rows of bead-like cells. The hairs are of a glittering pearly whiteness, very numerous, of wavy outline, like the tentacles of an anemone, and pointed at the end. They are not like the hairs of the corolla, complex, but of a simple tubular structure, without joints. The woodcut will convey an idea of the appearance which these hairy leaves exhibit under the microscope, and it will be readily understood, that as the leaves are closely compacted round the short stems, and as each leaf is furnished with a projecting mass of hair, the whole plant possesses the woolly appearance which Mr. Jackson describes, and from which, together with its shape, the appropriate name of "vegetable sheep" is derived.

LEAF.

I should be much obliged if any one who reads these pages in New Zealand would send to me, addressed to care of Messrs. Groombridge, some ripe achenes or seeds of this curious plant, and some flowers in a perfect state.

PLEASANT WAYS IN SCIENCE.

No. V.—Radiant Forces.

If a candle is placed in the centre of a room, it diffuses light equally in all directions, and consequently all parts are lit in regular proportion; upwards, downwards, on this side, and on that go the light rays, and if an obstacle meets them, they pass on either side of it, leaving a shadow behind it. The candle flame gives light because it is full of incandescent particles, each of which behaves in the manner mentioned; and we may figure the minutest conceivable particle bristling all round with light rays, which we might roughly imitate by sticking pins as close together as possible all round a tiny cork ball. We might approximate a little nearer to the truth, but yet be almost infinitely far from the wonderful minuteness of nature, by drawing with the finest pencil an immense number of the most delicate lines as close together as possible, and all radiating from one point, which would represent an incandescent particle distributing its light rays *in one plane* only, whereas the real particle distributes them in *all* planes.*

It is easy to draw two lines on a sheet of paper, diverging from the same point so gradually and so close together at the commencement, that at a distance of two or three feet they should be a very little way apart. Suppose, however, we were required to draw two such lines, which, commencing a slight divergence in London, should be found only an inch apart at York, how impossible would be the task. Still more impossible would it be for us to draw two lines for a few feet or a few inches which should have only such a rate of divergence that they would nearly touch each other if prolonged round the globe to New Zealand, or were extended some 240,000 miles off, until they reached the surface of the moon. The sun is about 92,000,000 of miles from the earth, and yet, according to the explanations usually given, each incandescent particle of his photosphere sends forth rays so tightly packed together, that many pairs of them reach our earth without the distance between them having become perceptible, notwithstanding they have been getting further apart from each other every yard they have advanced in their enormous journey! Still more astounding is it to conceive that the sun sends to the remote planet Neptune, which is more than thirty times as far from that luminary as our earth is, sets of diverging rays so closely packed, that many pairs of them

* An orange may be cut through its centre into slices, each slice representing one of the innumerable planes into which it may be conceived capable of division.

arrive at his distant surface, which deviated infinitesimally from true parallelism at the time of starting.

By drawing two diverging lines on a piece of paper, it is easy to see that at certain distances they can only reach bodies of proportionate dimensions. Thus, if at six inches from their point of starting, two diverging lines exactly touch the top and bottom of a perpendicular line one inch long, it will be found at six inches further, or one foot from their starting point, they will exactly touch the top and bottom of a line two inches long.

If it be desired to make these matters plain to young people, it will be better to construct a model than to draw a diagram. This may be easily done by fastening a pin to a piece of wood or cork, and carrying from it two lines of thread, to the top and bottom of a perpendicular line running through the centre of a piece of card two inches square, and one foot removed from the pin. A second piece of card, one inch square, should be placed six inches nearer, and the threads will exactly pass over the upper and lower surfaces of the two cards. Two other threads should then be extended so as to touch the cards at positions exactly at right angles to the former. It then becomes evident to the eye that a card one inch square, at six inches from the pin, which represents the source of light, can receive as many diverging rays as can be caught by a two-inch square at double the distance. But a two-inch square has a surface equal to *four* one-inch squares (as may be readily demonstrated by experiment*), and therefore, a portion of the two-inch square, equal to a one-inch square, could only receive one quarter as much light as the one-inch square could receive, through being at only half the distance of the former one from the source of light.

This model, or a diagram, will show, that for diverging rays to reach an object of moderate dimensions, like the two-inch card, a little way off the source from which they radiate, it is necessary that they should diverge at a very gentle rate. Rays that diverge rapidly can only be caught by a moderate sized object when it is placed near to the point from which they proceed, and even so large an object as our earth can only receive from the sun rays that for all practical purposes must be regarded as parallel, though a large number of them reach us with an infinitesimal divergence.

Astronomers calculate the quantity of light and heat that can be received from the sun by the different planets revolving round him, by estimating their distances from the central orb.

* In teaching young folks, or uninstructed adults, these things should be shown by cutting pieces of card, and placing four one-inch squares on one two-inch square.

If we receive a quantity which we may term x, a planet twice as far off would receive only one quarter of x quantity; and one three times as far off one ninth, and so forth, till we come to such remote planets as Uranus and Neptune, when the fraction becomes minute.

If we adopt the explanation of *diverging rays*, the sun may be regarded as an infinite number of incandescent points, from each of which proceeds one ray, which we call a direct ray, as it proceeds straight forward towards our earth. Of such rays, only those could reach us which emanated from a surface not larger than our own, or so little larger, that the effect of the refractive action of the ether of space, if such there be, and of the refractive action of our atmosphere, could still bend them so as to reach us. Each particle of the solar photosphere would be supposed to emit one of these direct rays, and an infinite number of rays slanting more or less away from it on each side. Now, however slight may be the divergence of any two rays, there must be a distance beyond which they could not both touch any object of given dimensions. Let us suppose, for example, the case of two rays which diverge at the rate of an inch in a million of miles. They could not both fall upon an object rather more than a million of miles away from their starting-point, and not more than an inch in diameter. At exactly one million of miles' distance they would both meet the edges of such an object, but beyond that distance they would pass by it, and at two millions of miles they could not both at once be nearer than within half an inch of it, though one might touch it, and the other be still further off, if it were appropriately placed for such a result.

The proportion of diverging rays which planets could obtain from the sun would follow the rule of inverse proportion that has been explained, but not so the rays that come from him in parallel lines. If they were not obstructed by any medium diffused through space, they would go on for ever without diminution; and if there were two bodies smaller than the sun, and at gigantic distances from it, the nearest being so far off that it could not receive any diverging rays emitted by the sun, and the remotest three times, or ten times, that distance, they would both be equally well illuminated, and would receive equal quantities of light on equal areas of their surface.

As light may be considered, with approximate certainty, to consist of vibrations of a highly attenuated fluid, which has not yet been discovered to possess any weight or sensitiveness to the action of the attraction of gravitation, we must suppose such a fluid diffused through space, and capable of transmitting the light waves. This fluid has been thought to oppose a certain obstacle to the passage of light waves, so that it could not pass

along an immense space without a loss of power; and a sufficient length of space might at last bring it to a state of rest, which would be equivalent to destroying its character as light. Indeed, that character would cease long before rest was attained, because no eye, constructed upon the principles of human eyes, could be impressed with the sensation of light, unless the velocity of the ether vibrations were sufficiently great. As soon as they declined below a certain quickness, they would cease to excite the sensation of light, and vision can take no cognizance of them.

If light were regarded according to the Newtonian theory of its consisting in an emission of particles, mathematicians would have to calculate how closely it would be possible for independent light-streams to be packed together; and when assigning to any two of them an infinitely small divergence, to compute how far they must travel before the divergence would increase to such an extent, that they must pass on either side of an object like our earth or one of the planets. It would be interesting to know, according to this theory, what proportion the truly parallel rays from the sun would bear to the diverging rays which strike upon the various members of his system.

The emission theory is, however, generally abandoned, and the term "ray" needs special explanation when used in connection with the undulatory theory of light. If we throw a stone in the centre of a still pond, we notice a series of concentric hollows and ridges, spreading out wider and wider, and growing fainter and fainter, until, if the pond be large enough, they gradually vanish in the smooth surface. If the pond is small in proportion to the size of the stone and the force with which it strikes the water, strong waves continue up to its banks, and are reflected back again, producing noticeable interferences with advancing waves. Now in these actions, or in the first of them, the spreading of waves from the centre to the circumference of the pond, we do not notice any analogy to "rays;" but if we consider that every hollow and ridge consists of multitudes of water particles in a state of oscillation, the term "ray" might be applied to each diverging series of particles, arranged in sets, one in front of the other, which oscillate or move up and down in the same vertical plane, and which all owe their motion to a transmission of force from one of the originally moving particles. From the cohesion of the water particles there are no lateral gaps between these water "rays." Each particle of water imparts its own motion to its neighbours, and as the waves increase in size, the number of particles in motion becomes greater. The effect of this constant addition of particles to the wave system is, that the

original quantity of motion has to be divided amongst a greater number of particles, and consequently each one will have less. Thus the further the waves are away from the stone, the less will be their height and depth; or the smaller they will become when measured *vertically*, although they are greater in breadth.

This water comparison does not, however, afford a complete idea of the propagation of light, because we notice only what takes place at the surface of the water. If a diver exploded a circular mass of gunpowder at a given depth, the water would be struck equally in all directions, and the wave produced would be like a series of spherical shells, one outside the other. Each shell would contain more water particles than the one next to itself and *nearer* the source of motion, and fewer particles than the one next to it and *further* from that source. Thus in the spherical waves nearest the explosion the motion of particles would be violent, and it would grow less and less violent as the spherical waves grew wider and wider, as they receded from the centre of explosion.

A particle of matter becoming luminous acts like the explosion supposed in the case of the water. It communicates a strong wave motion to a spherical shell of the adjacent ether, and the particles of that first shell hand it on to a second, and so on in infinite progression. As long as the waves have force enough to be visible we call them light. If the ether particles have sufficient attraction for each other, the process must go on, as in the case of the water; but is this known to be fact? Is it certain that the spherical shells of light are continuous and without break in the sense in which spherical water waves possess that property?

If we consider light as propagated in waves like concentrated spherical shells, a light ray will consist of the oscillations of all those particles which stand in front of the first moved particle, which acts as their source of motion, by communicating to them its own motion.

Optical experiments show that one set of light rays may be made to pass through another set without apparent loss. The method of illuminating opaque objects under high powers, originating with Professor Smith, of Kenyon College, as described in a former number of the INTELLECTUAL OBSERVER, and well-known in this country through the contrivances of Mr. Richard Beck, and Messrs. Powell and Lealand, illustrate this fact. Light rays are sent down through the object-glass on to the object, and then, being reflected by the object, they come back again without jostling one another, so far as can be discerned. But, by another kind of experiment, light waves can be made to interfere with each other, and produce either

total darkness or distinct colours, according to the exact nature of the interference which takes place.

Optical experiments show that the light we receive from distant bodies, as from the sun, behaves as if it were composed of a number of rays exactly parallel to each other, while the light received from near objects behaves as if it were composed of rays not parallel, but diverging from a common centre. These facts seem to throw us back upon the conception of really divergent rays, as contradistinguished from parallel rays, and thus would lead us to set us to reject the supposition of strict analogy between the spherical water waves, already spoken of, and the waves of light. We shall, however, find that the difficulty arises from accepting the term "diverging rays," as expressing a literal fact, and not merely affording an approximate illustration.

If we pass from light to gravitation we find another instance of a force moving in straight lines, and varying inversely as the square of the distance at which it operates. Bodies attract each other in proportion to their masses, and the force of that attraction diminishes as the squares of the distances increase. This law is found to hold good for Neptune, the remotest known member of our system, and which, as we have remarked, is more than thirty times as far off the sun as the earth is.

We have as yet no means of showing or establishing a connection between gravitation and other properties of matter. Light, heat, electricity, chemical attraction, magnetism, and mechanical force all stand in a certain relation to each other, and are susceptible of conversion into each other. No one, however, has succeeded in depriving any body of its gravity, and thereby causing the gravitation force to assume a new form. It may be an ultimate and permanent property of matter, or what seems more probable, a property of matter under certain conditions; but we have no idea how it is correlated to other forces which matter exhibits. We have reason to believe that it is propagated in all directions like light, and Newton showed that bodies gravitate towards each other as if their matter were concentrated in one central point, corresponding with what is known as their centre of gravity.

A luminous body emits light, whether or not there is anything which it can illuminate; but we only know of gravitation as a reciprocal action of two bodies upon each other. When a man jumps he kicks the earthball from him with a force proportioned to his own rebound, and if the earth were a little thing, its position would be displaced. As it is, the displacement, though existing theoretically, is too small for appreciation or for computation in intelligible figures. In like manner, when

the earth attracts a falling stone, that stone attracts the earth, but if the stone weighs, or is attracted with a force equal to one pound, and attracts or pulls the earth with equal power, the stone falls, and the earth does not visibly or appreciably rise to meet it, because a one-pound pull at the great globe is practically lost in the ponderous mass.

Electric currents will not traverse the most perfect vacuum we can produce, but light easily traverses any vacuum we can form. Thus we know that it consists of the motion of a more attenuated medium. Gravitation traverses space, and light does the same; but do they do it in the same way? In the case of light there is a transmission of the wave form through the delicate matter which seems to fill celestial space. Is gravitation in any way dependent for its transmission upon this or upon any other form of matter? Could it be stopped, as an electric current can be stopped, by taking away the material particles in space? Or do distant bodies act upon each other with this gravitating attraction without any help from intervening materials? If light be the vibration of ether, its transit must stop if that ether were not present. Does gravitation in any way present an analogy to light? or does it stand alone, having some of the properties of a radiant force, and yet consisting in no motions, and occupying no space for the transmission of its powers?

Whenever we come to ultimate questions we enter into the domain of the unknown. We say light consists of the oscillation of ether particles, each one moving in an extremely minute curve, and stimulating its next-door neighbour to do the same, so that a wave is produced. We are, however, not in the least degree able to explain why such oscillations of particles should produce on our organs the effects of sight. We consider heat as a mode of motion, but we have no idea why a brisk motion of the particles of a candle causes them to burn, or combine with oxygen and give us light. In like manner, if we reduced gravitation to the category of modes of motion, we could not then understand why two bodies should thereby want to come near each other. Nature is full of these mysteries. We trace her facts, and we note their sequence. Our minds, impelled by will, actuated by design, lead us to appreciate the law and order we can discover. We naturally and irresistibly attach to the word *cause* something more than regular but unconnected sequence. As a result of watching the uniformity of natural operations, we form a conception of inevitable and necessary sequence, and we proceed from inevitable and necessary sequence to the assumption of a cause sufficient to make any sequence inevitable or necessary; and, failing to see such cause in the motions of physical particles, we arrive

at the conception of a mental and moral cause adequate to the production of the effects which we observe. A philosophy of science which can rest satisfied that man's most heroic purpose and action is nothing more than an oxydation of particles, can only satisfy a few abnormal minds. Such may be wanted to assist in the process of rigid analysis and investigation, to which they often supply a valuable negative stimulant; but from the earliest times in which speculation existed, down to our own, an overwhelming majority of the greatest intellects have taken another view; and while some have regarded physical forces as merely the exponents of moral and intelligent forces, all have seen in secondary causes the proofs of an ultimate cause; and have regarded the universe not as dead and material, but as spiritual, living and divine.

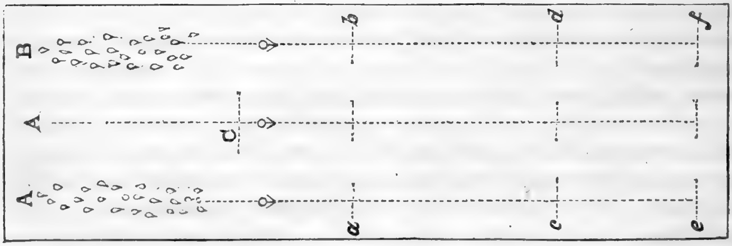
The present paper is put forward tentatively, with a view to promote *thinking* on the subjects to which it alludes. Text books and teachers too often leave students with technical statements, which, although correct, supply only an appearance of knowledge to those who accept them without careful examination. The intricate nature of optical questions, necessitates considerable mathematical knowledge for their complete exhaustion, but the questions started in this paper ought to be susceptible of elucidation, so far as main principles extend, in the language of common life.

Our line of examination seems to show, that if light is presumed to propagate its undulations in concentric spherical waves, it is inexpedient, as well as incorrect, to speak of *diverging* and *parallel rays.* What are called diverging rays would be the supposed radii of the circle or sphere formed by each wave. Parallel rays would be merely a portion of a spherical wave having a large diameter and a low rate of curvature for any small portion of it; while diverging rays would really be a portion of a smaller sphere with a greater curvature of a given portion. A part of the circumference of a sufficiently large circle is approximately a straight line.

SCHRÖTER'S METEORS.—THE LUNAR CASSINI.—CRIMSON STAR.—OCCULTATION.

BY THE REV. T. W. WEBB, A.M., F.R.A.S.

THE examination, in our last number, of Schröter's remarks on Light-spots on the dark side of the moon, naturally leads to a curious observation by the same astronomer, of a very unusual meteoric appearance, with which he closes his chapter on the subject. He tells us that on Oct. 15, 1789, about 5h. 10m. or 15m. A.M., as he was examining the dark side of the moon, then more than 25° high, with a power of 161 in his 7 ft. reflector, and had *Plato* and the *Mare Imbrium*, but no portion of the illuminated hemisphere, in the field ;—there and then, in front of the dark globe, and as far as his surprise would allow him to judge, in the centre at once of the *M. Imbrium* and the field of view, broke out in an instant a stream of light, consisting of many separate little sparks, white and brilliant as the enlightened part of the moon. They took a straight course to the N., away in front of the N. part of the *M. Imbrium*, the nearest limb of the moon, and the small vacant remainder of the field. As this stream had completed half its course, another, exactly similar to it in every respect, broke out nearly in the same place where the first appeared, but a little further E., which moved in a line parallel to its predecessor and passed away in the same direction out of sight. He has given a diagram, of which a



reduced copy is inserted here, where A is the 1st, B the 2nd stream, which broke out in B when A had reached C. *a b* being the border of the *M. Imbrium*, *c d* the limb, *e f* the edge of the field.

Startling as was the impression which this distant scene made upon our observer, he soon recovered from it, and repeatedly renewed to himself a lively idea of what he had witnessed in order to compute the time of its duration, when he found that the visible course of each stream had lasted about

2s., and consequently the whole duration of the phenomenon about 4s. (*sic in orig.*) till its final and entire extinction. The circumstances of the observation showed sufficiently that this display could not be referred to the lunar surface, but must have been developed much nearer the earth. The streams were not larger than the representation in the original drawing held 18 inches from the eye, or about 9 inches for our reduced copy, and they caused no perceptible illumination of the field. This was only 9′ in diameter, of which they occupied about half, or 5′, $\frac{1}{6}$ of the diameter of the moon, and each stream took some 2s. to traverse this little distance. Hence Schröter infers that the meteor was situated at a remoteness from the earth far exceeding the general idea of the extent of our atmosphere. This is not improbable; and it may be thought not unlikely that the observer was actually fortunate enough to catch sight of a portion of one of the meteoric rings which are now believed to intersect at certain times the earth's orbit—the principal difficulty lying in the circumstance that his little sparks were kindled in the middle of the field, instead of coming into sight at its edge. However, if this were so, it would seem to follow that these mysterious bodies are not ignited by the resistance of our atmosphere, but must exist in a self-luminous condition.

Telescopic meteors are uncommon, but perhaps not more so than might be expected considering the smallness of ordinary fields as compared with the extent of the sky. I believe that I have more than once seen something of this nature;—and on one occasion, 1847, Aug. 31, I have expressly noted that a minute falling star passed across the field of the telescope which must have been totally invisible to the naked eye. But a more curious instance may be found in the description which Schröter published (in 1796) of his 27-foot reflector. This grand instrument, which was mounted in 1793, had two nearly equal metallic specula, the largest measuring $19\frac{1}{6}$ English inches; and seems to have performed very well for its date, though it may be questioned whether any work of that day was equal to what is now successfully accomplished, especially on glass surfaces. Its front-view action on the starry heavens seems to have been very striking: and though of course not equal in grasp of light to the 40-foot reflector of Herschel I., must have had some little advantage over the more frequently used 20-foot of the same observer. His description of its resolution of the galaxy is interesting. Even in the dark opening near α *Cygni*, he found several little stars; only a tolerably circular space of about 4′ appeared free, yet even in this void he presently detected an extremely minute glimmering point. But on a subsequent occasion the impression of allowing a rich part of the galaxy near the same spot to pass through the field of 15′

of arc, from 6h. 20m. till nearly 8h. P.M. is thus simply recorded—"what Omnipotence!" During that time upwards of 80 fields had passed before his eye; but in not one of them, even the least rich, was he able to number the multitude of stars. Repeated estimation gave him never less than 50 or 60 at once; frequently 150 and upwards; 80 might be considered an average; and this would give 1630 stars per square degree, or 48,900 in an extent of the galaxy 15° long and 2° broad. This estimate gives a close agreement (of course, rather accidentally) with the 50,000 of Herschel I. deduced with the 18-inch aperture of his 20-foot reflector: and hence would follow Two Millions for the whole circle of the galaxy. A more extended comparison led Schröter to think that his telescope would reach upwards of Twelve Millions in the whole compass of the sky. Assuming an equality of reflective power for this speculum, and that of the Earl of Rosse, we should either have for the large telescope of the latter, about 170 millons of stars, or else be obliged to suspect that we had passed

"Extra flammantia mœnia mundi,"

beyond the bounds of visible creation, and were able to gaze out on blank and empty space. And though we have now learned to distrust the formerly current assumption of equality between our sun and those galactic stars, and consequently may conjecture the possibility of a less extended boundary to our telescopic range, yet we cannot help admiring the worthy old Hanoverian when he tells us how the observer is "perpetually finding in the apparently remotest confines of creation new and certain traces of creative power extending itself indefinitely further, and as it were a continually new reflection of the Deity in his great works of nature. In astonishment he here adores Infinite Omnipotence in these wonders, and longs for further and greater discoveries from posterity."

But to return. On June 28, 1795, after examining the more than half illuminated moon with a power of 183 and a field of 15′ in this great instrument, he was looking at a part of the constellation *Ophiuchus*, and noting the continual passage of the minutest stars through the field, 6 or 7 at a time, when an excessively delicate and faint point of greyish light, exactly like a falling star at an extreme distance, passed downwards across the field in about 1 second. It was not brighter or larger than the minute stars in the field, or than those in the galaxy, and smaller than any previously known magnitude, not resembling a meteor in our atmosphere, but probably flying in the expanse of ether; this latter according to the views of Schröter differing only from the atmosphere of the planets in its greater rarity, and the absence of the exhalations arising from the

neighbourhood of each celestial body. This idea, however, of the enormous distance of his meteor was merely an optical impression, and however probable it might be, it would be interesting to test it by calculating at what distance from the earth the average velocity of shooting stars would cause them to traverse 15′ of space in 1s. of time. The data for this are not sufficiently certain to lead to an accurate result, because the speed of individual meteors is very variable, but we may make a rough approximation to it. It appears from Professor Grant's recent observations on the November meteor-shower, that an arc of 60° described in 3s. would represent a great proportion of their courses: taking this as a basis we shall find by an easy reckoning that Schröter's meteor had 80 times less apparent velocity and therefore may be supposed to have been at 80 times greater distance. With every allowance for the uncertainty of such a computation it certainly seems probable that he had reason for supposing that it existed in the depths of space, and that it must have been of a self-luminous character.

We will now, after a long intermission, proceed with our topographical illustration of the lunar surface. The W. extremity of the *M. Imbrium* was called by Riccioli the *Palus Nebularum* and the *Palus Putredinis*, the former lying N.E., the latter S.E., of the No. 16 in our map. These plains are of very level character, and elevations of 250 feet are there of importance, especially in the former, where the terminator forms a clear line, and risings of even 50 feet, if broad enough, could not escape the eye. At the edge of this level, we come upon a very peculiar walled plain, *Cassini* (20), the omission of which from the maps of Hevel and Riccioli led Schröter to the precarious idea that it was of a subsequent date.* How little confidence can be placed in such a negative argument will presently appear, in a smaller but sharply-defined instance. The ring of *Cassini* is very narrow, and lowest towards the four cardinal points, but rises on N.W. to nearly 4400 feet above the plain, the interior being very little, if at all, depressed. I have seen it casting three grand obelisks of shade, two very near together, across the external level. It contains, according to B.

* B. and M. have made it a charge against Schr. that in his anxiety to discover change, he had asserted that *Cassini* was as obvious (augenfällig) as *Aristillus* and *Autolycus;* and they draw attention to the fact that those craters throw shadows visible even in a comet-finder, at a time when *Cassini* would be nearly imperceptible. What Schr., however, actually says is something quite different; viz., that there is no trace of *Cassini* in those two maps, though they contain the neighbouring *Aristillus* and *Autolycus*, which is not so large as *Cassini*, with the yet smaller *Calippus* and *Theætetus*, and the border of the *M. Imbrium*, and that it is not found in the "Phases" of Hevel close to the terminator, though *Autolycus* and *Aristillus* are shown under much higher illumination. *Judicet Lector.*

and M., three small craters; one (A) very deep, precipitous, and conspicuous; a smaller one adjoining it, S.W., and a third close to the S.E. main wall. They speak of having measured A ten times, and their book contains an additional diagram of *Cassini* on a much larger scale, not referred to in the text, but taken apparently with the great Berlin 9·6-inch achromatic, and dated 1836, Sept. 1. And in neither of their delineations, nor in the text, is there the least indication of anything in the interior of A. This might appear conclusive. Yet ten years before that elaborate drawing, and eleven before their description, I had seen something there with a 5-ft. achromatic which I drew and described as a "bright object with shadow, whether central hill, or projection on the declivity, or small encroaching crater, I could not make out." I have since frequently noticed it, and any one may see it even with a small telescope under suitable illumination. I have doubted whether it might be an eccentric hill, or the edge of an interior and deeper crater; but rather inclined to the latter. A sketch obligingly sent me by F. Brodie, Esq., represents it from an 8½-in. object-glass, as a defective wall between two confluent craters. I have not as yet brought to bear upon it the sharp definition of my 9¼-in. silvered mirror. Should it be a deeper interior cavity, it might add a third to a rare class, of which two instances are pointed out by Schmidt, where a subsequent eruption has produced a ring contiguous to, but distinct from, that of the more ancient formation.

But whatever may be its nature, we may well ask how it could have escaped the notice of B. and M., especially at the time of a special delineation so minute in detail as to show even a deviation from circularity in the form of A, as well as variations in the height of its ring? So marked an omission in the midst of so much display makes us feel how unsatisfactory it is to argue the question of lunar changes on no other data than those furnished by the most seemingly careful drawings of previous authorities. It is to the labours of such men as Birt and Schmidt that we must look for the solution of this difficulty.

But we have not yet ended the story of *Cassini*. B. and M. have spoken of a second considerably smaller crater enclosed by an imperfect ring, as lying close to the S.W. side of A:—S in the detailed drawing, where it is much smaller in proportion. I have seen what corresponded exactly with this; but further examination has led me to believe that it is not a crater but a mere gorge or hollow on the E. side of the spot where a long buttress, as it were, lies against the S.W. wall of A. This ridge was well seen and drawn by Schr. in 1798, when he also saw two mountains casting shadows outside the N. main

wall, and as he had never seen anything of the kind during the observations of eleven years, he inferred that the former was probably some temporary appearance in the lunar atmosphere, and that the latter had previously been hidden from some similar cause. Here he seems to have been mistaken. The latter —the two mountains, appear in B. and M. and L.: but further from the ring: the former I saw, 1826, May 15, and frequently since, and anybody may see it readily who looks under proper illumination. But if long missed by Schr., it was mistaken by B. and M. for part of a crater-ring; and even their larger drawing does not give its character well, as a ridge gradually ascending till it joins the top of the wall.

On the whole, *Cassini* would form an admirable object for amateur study. Its character is intrinsically interesting; it lies in a very convenient position; it is simple in form and easy of delineation; and though it has been many times meddled with, it has evidently never had complete justice done to it. It should be drawn under many angles of incident light; and not only its morning and evening illumination should be carefully represented, but the peculiar local colouring of its noonday aspect. Such a monograph could hardly fail to be alike improving to the student, and valuable as an addition to "selenotopography."

CRIMSON STAR.

A remarkable specimen of a red star may now be found with little trouble. *Regulus*, or *a Leonis* (which, by the way, though rated 1 mag. seems hardly entitled to the distinction), forms a large obtuse-angled triangle with two attendants: one, η, 3 mag., nearly *n*; the other, *o*, 4 mag., considerably further, *p* a little *s*. If we now connect these two by a line, we shall find, about $\frac{1}{4}$ of the distance from *o* towards η, a 6 mag. star, 18, just visible to the naked eye in clear air: a little *sf* this, in the finder, is a small group of four stars, one of which is the crimson star R *Leonis*; so called as being variable, according to Argelander's mode, now generally adopted, of designating such objects by some of the later letters of the Roman alphabet. Its colour is very fine, though not so intense as that of R *Leporis*, with which we hope many of our readers are by this time acquainted.*

In looking at it in a former season, I was struck with a curious effect of contrast in colour. The celebrated binary γ *Leonis* (104 of our list) has just *s* of it a 6 mag. star, 40. This in the finder had struck me as being of a pale blue verging to lilac, when, on examining it with the $5\frac{1}{2}$-inch achro-

* *Intellectual Observer*, ix. 176.

matic, I was surprised to find it distinctly pale yellow; and, from the intensity of light with the larger aperture, it did not lose this colour even when brought face to face with γ in the large field of the comet eye-piece. Its real tint, then, had been suppressed, in the finder, by the superior strength of the yellow rays of its overbearing neighbour, and even forced into a slightly complementary hue. As I have no reason to think this a peculiarity of my own vision, it may serve to show how much caution must be used in deciding upon the tints of the lesser components of pairs, when the larger is of any decided colour; and this, it seems, will be especially the case in proportion to the apparent smallness, as well as, of course, the closeness, of the pair. For not only is the effect of contrast increased by the juxta-position of the images on the retina, but by difference of brightness, enabling the stronger to force a complementary tint upon the weaker light; and difference of brightness, again, becomes more sensible in proportion to the diminution of the total quantity of light; for it has been remarked by H., that "to any one accustomed to the use of large telescopes, the fact must be familiar, that the apparent inequality of two stars seen at once in the same field of view diminishes as the light of the telescope is greater." Hence it may be conjectured that, could we be gradually transported nearer and nearer to some remote and obscure pairs, where an orange is associated with a much feebler blue companion, we should find the difference of colour decrease as the brightness was augmented, till at length the blue might become white, or even yellow, when liberated from the preponderance of the superior tint. And hence follows the importance of examining suspected star-colours with different apertures, and relying chiefly upon comparisons of observations with the same instrument.

The effect of contrast in colour is pleasingly illustrated by the following anecdote of the late great French painter, Delacroix, related some time ago by Alexander Dumas, at one of his "conferences":—"Delacroix used to tell, that it was while painting *Marino Faliero* that he had discovered his theory of colours. He required for his decapitated Doge and his senators cloaks of cloth of gold, and he had employed to no purpose the most brilliant yellows—his cloaks continued of a tarnished appearance. He determined then to go to the Louvre, to study the works of Rubens, to attempt to steal from this second Titan the fire of heaven. He accordingly charged Jenny, his housekeeper, his manager, his nurse—in a word, his *maitre Jacques*—to go and bring him a cab. Jenny came at the end of a quarter of an hour to tell him that the cab was at the door. Delacroix descended his staircase rapidly, and,

always greedy of time, ran to the vehicle he had ordered. I do not know whether any, among the persons who hear me, may recollect having seen, at this period, canary-yellow cabs—that is, of the fiercest (*la plus farouche*) yellow that can be seen. Delacroix stopped short before the body of his cab; it was a yellow like that which he wanted; but in the position where the carriage was placed, what gave it that dazzling tone? It was not the tone itself, it was the shading which made it come out. But these shadings were violet. Delacroix had no further occasion to go to the Louvre; he paid the cab and went upstairs to his room: he had caught his effect." The observer of double stars may sometimes do well to bear in mind the cab of Delacroix.

On re-examining R *Leonis* with a $9\frac{1}{4}$-inch silvered glass speculum, by With, 1867, Feb. 2, I found the colour very fine, though the magnitude was much diminished from what I had previously seen. Its variation ranges, according to Pogson, from 5 to 10 mag., with a very irregular period of about 312d. I do not know whether it may now be on the increase or decrease; if the latter, it should soon be looked for, before its colour becomes less striking for want of light. There seem to be only two ways of accounting for the singular colour of these very beautiful and striking objects; reckoning from terrestrial analogies, it might be due either to simple ignition or to peculiarity of composition. There is no antecedent improbability in the former supposition; one sun might as readily exist at a red, as another at a white heat. But it appears to be negatived by the fact, that our terrestrial red-heat is attended by an inferior degree of luminosity, in accordance with its low temperature, hardly corresponding with the vivacity of stellar light. It seems, therefore, more likely that this tint is derived from a peculiarity of elementary composition, which it would be most interesting to ascertain, but which is never likely to be disclosed to mortal research. The colossal reflector of Parsonstown may indeed give so great an intensity to a 5 mag. (the largest attained by any distinctly crimson star), that the spectroscope, which has been recently prepared for it by the skill of Mr. Browning, may be able to effect its analysis; but the probability is, that like our sun through a great extent of its spectrum, it would only exhibit to us a hieroglyphic inscription to which we possess no key.

Occultation.—March 22nd, κ Virginis, $4\frac{1}{2}$ mag., 9h. 28m. to 10h. 17m.

SCHMIDT ON LINNÉ.

Extract from a letter addressed by Herr Schmidt to W. R. Birt, dated Athens, 1867, January 25:—

"From 1866, October 16th, to 1867, January 24th, I have observed Linné at every opportunity the weather permitted, the result being as follows:—

"1st. In high illumination Linné is *always* as in preceding years, visible as a light spot, somewhat fainter than γ Posidonius. The difference of the sun's height has then no perceptible effect upon its appearance. Not until the sun's height becomes less than 5° is the light spot smaller and fainter.

"2nd. In lower altitudes of the sun and close upon the phase, not only is a crater *never* visible, but there appears in good light, and with magnifying powers from 300 to 600 at most, a very delicate hill of 300 toises (1918·4 English feet) diameter, and five to six toises (between 30 and 40 English feet) in height. As a *crater* Linné has entirely disappeared.

"The *light spot* is *always* visible, but the crater-form has never been visible from October until the present time.

"January 24d. 17h. 18h. Linné had a faint light-tail of a mile (3800 toises or 4·6 English miles) in length, which I had not remarked since October.

"January 25d. 14h. to 16h. Light exceedingly good, decreasing sun height on Linné, now 12° to 13°. *No* crater and the light cloud visible. In it (as on December 26) a very faint black point, to the west of it a fine white summit."

ARCHÆOLOGIA.

We have the satisfaction of opening this month with the announcement that, by a great act of generous and munificent public spirit on the part of its proprietor, the well-known Mayer Museum has become the property of the town of Liverpool, and, therefore of the nation. The name of Joseph Mayer has left a lasting impress on the archæology of this country. In the struggle to raise archæological science from the low condition into which it had fallen half a century ago, which resulted in the establishment of the Archæological Association and the Archæological Institute, Mr. Mayer was an active coadjutor, and from that time to the present he has ever been the first to offer his assistance either in promoting excavations or discoveries or in aiding in the publication of works of historical or antiquarian utility. As an example of what he has done in this latter class of labours. we need only mention the *Inventorium Sepulchrale* of Bryan Faussett,

edited by Mr. Roach Smith, the most important work we possess on the Anglo-Saxon antiquities of the pagan period, and the *Volume of Vocabularies*, which throws so much new light on the antiquities of the middle ages, both costly works, printed entirely at Mr. Mayer's own expense. During now a rather long period of years, Mr. Mayer has laboured in collecting what may truly be called a princely collection of antiquities, at an expenditure of many thousands of pounds, and all English antiquaries of our day will remember with how much interest they visited, and with how much new and interesting knowledge they left, the two large adjoining houses in Colquit Street, which he had fitted up for the reception of his treasures. But for Mr. Mayer's zeal and liberality, the celebrated Faussett collection of Anglo-Saxon antiquities, taken chiefly from the pagan cemeteries of East Kent, and forming one of the most important of our early historical monuments, would probably have been dispersed, while it now forms one of the gems of his collection. He bought, we believe, the collection of antiquities of Mr. Rolf, of Sandwich, the excavator of Richborough (the Roman *Rutupiæ*). Nor is the mediæval portion of the Mayer Museum inferior in importance to that which contains antiquities of an earlier period, and it must not be forgotten that his collection of porcelain, and more especially of Wedgewood ware, is the most perfect in the world. The Egyptian antiquities, and those of the Greek and Roman periods, are also very rich and remarkable. The only condition which Mr. Mayer has placed upon this noble gift to the town of Liverpool is, that it shall be preserved entire, and that it shall always preserve the name of its donor. We can feel no doubt that the town of Liverpool will show its appreciation of the gift, and of the spirit in which it was given, by placing it in a convenient building, and making it as accessible and useful as possible to the antiquarian student and inquirer.

The excavations in the Treveneage Cave, near Penzance, are still in progress, and we hope shortly to be able to give a more full and complete account of the results. Since we spoke of them last month, the fragments of an earthen vessel, supposed by Mr. Blight to be Roman, have been sent to us, and they are certainly not older than Roman, but, on the contrary, they resemble rather closely the pottery of the early Anglo-Saxon period found in the pagan cemeteries, examples of which will be found in Mr. Roach Smith's *Collectanea Antiqua*, and in other works. Other fragments have been found in the passage in the cave, described in our last, which, as far as we can judge by drawings, are clearly Roman, and there are traces of Roman occupation over the whole of this district. The cave is situated above ancient tin-works; and the valley, which terminates just against St. Michael's Mount, was no doubt in earlier times searched for tin. In the time of Henry VIII., ancient bronze weapons were found here, as recorded by Leland. There is a well-known Roman camp at no great distance, and numerous Roman coins have been found in the locality. Within a quarter of a mile of the cave, there was found, a few years ago, a stone bearing a Roman inscription, built into the wall of St. Hilary Church; the

inscription was read FLAVIO JULIO CONSTANTINO PIO CAESARI DIVI CONSTANTINI PII AUGUSTI FILIO. This, of course, referred to the Emperor Constantine II., or, if the first name may have been mis-read, to Constantius II., whose names were Flavius Julius Constantius. The latter was entrusted with the administration of Gaul at the early age of fifteen, in A.D. 332. We are informed that, in connection with these remains of ancient mines, there are traces of the metal having been smelted on the spot. There were found, among the earth which filled the cave, besides the fragments of pottery already alluded to, large quantities of a coarser kind, portions of iron instruments, a quern, and other articles of stone, with a good flint flake; and also great quantities of charcoal and bones of animals. Amongst the pottery are two or three bits curiously perforated, "as if the cord had been passed through the holes alternately from one side to the other." The cave is surrounded by a great trench, which the excavators are now following up. Mr. Blight adds, in his note, "In a similar cave a few miles distant, a fragment of Samian ware was found two or three years ago, and it is rather curious that fragments of the same ware have been procured from a Scottish Pict's house. These Pict's houses are constructed very much after the manner of the Cornish caves."

The British Archæological Association has just published the full details of the discovery of the ROMAN BUILDING on the shore of GURNARD BAY in the Isle of Wight, drawn up by the Rev. Edmund Kell. It consisted of three rooms, or at least of one middle room and the greater part of two others, at the termination of an ancient road (no doubt Roman) called Rue Street, which runs across the island from north to south. These rooms present the appearance of having formed one side of a court of a larger building, and were evidently rooms for ordinary purposes, as they were rather coarsely paved with small tiles. A good number of Roman coins, with fragments of Samian ware, and other pottery, pieces of building materials, and various other objects, including a mutilated bronze figure of Mercury, were found scattered about. Among other things found here were exhibited a number of small discs of lead, stamped with marks, and with letters, the more numerous examples of the latter consisting of the combination C. T. The circumstances under which these were found seems to suggest the belief, held by Mr. Kell, that they are Roman, and there is nothing about them to urge us very forcibly to a different conclusion. They certainly remind us of the Roman leaden seals, of the same character, which have been found at Brough upon Stanmore in Westmoreland, and at Felixstowe in Suffolk (both the sites of Roman stations), and examples of which have been engraved by Mr. Roach Smith, in his *Collectanea Antiqua*, vol. iii., p. 197. The latter, however, are much less rudely engraved, and present more elaborate designs, with more numerous combinations of letters, than those found at Gurnard Bay; they seem to have been connected with some class of commerce carried on in this distant province during the Roman period with which we are at present totally unacquainted. With the Roman coins at Gurnard Bay were also found a few Greek coins, all of copper.

The presence of Greek coins in ancient Britain appears to be generally regarded by numismatists with great doubt, and one of our most experienced numismatists believes that, as far as they are concerned, this is not a genuine "find." Yet in several instances, as, for instance, at Exeter some years ago, Greek coins are said to have been found under circumstances which do not point to any suspicion of fraud; and we see no reason why, in the course of commerce, Greek coins may not have been frequently brought into our island. On another point, however, we entirely differ from Mr. Kell. We cannot see that this discovery of the remains, probably of a Roman villa, has any connection with the history of the tin trade, or that it furnishes any evidence whatever that the trade of tin from Britain was ever carried through the Isle of Wight; it simply shows that the Romans did occupy this island, a fact of which we had abundant evidence before.

The *Reliquary*, edited by Llewellynn Jewitt at Derby, continues to contribute very worthily its quarterly contribution of good and interesting archæological knowledge. We mention it on the present occasion for the purpose of calling attention to the catalogue of ARCHÆOLOGICAL PRODUCTS OF THE SEA-SHORE OF CHESHIRE, collected during the year 1865, published in the last quarterly number. It has been known for some years that great numbers of antiquities, of all periods, at least from the Roman age, are continually washed up on the beach along the Cheshire coast, from the mouth of the Mersey to that of the Dee, apparently suggesting that a very considerable portion of the space here now covered by sea was at some remote period dry land, which has been gradually washed away. The catalogue to which we allude gives a detailed description of all these objects, to which we refer the reader, and we will content ourselves with merely stating the general character and numbers of the objects of antiquity known to have been thus found during the one year just mentioned. Of flint implements, including a number of arrow-heads, and others of stone and shell, classed under the head of primeval, the number was thirty-three. There were found during the same period twenty-two objects belonging to the Roman period, many of them of rather remarkable character; and an Anglo-Saxon sceatta, with two or three objects in metal, which it is probable may be considered as Anglo-Saxon. The number of objects found on this shore, which are classed under the head of mediæval, is much greater, amounting in all to upwards of a hundred. Among them are a halved penny of the reign of Henry III., and a perfect penny of Edward III.; many pins, needles, personal ornaments of very varied character, pottery, etc., and especially a portion of an equestrian figure in light-coloured and glazed earthenware, belonging to a class of works of art which is excessively rare, and which is generally ascribed to the twelfth century. There were also found —belonging, of course, to a much later period, a silver shilling of James I., a horse-shoe of the seventeenth century, a rowel spur, a large iron ring, and, in all, nearly two hundred heads of clay pipes, ranging from the reign of Queen Elizabeth to the beginning of the last century. We owe the labour of drawing up this curious record of discoveries to Mr. H. Ecroyd Smith.

PROGRESS OF INVENTION.

Economic Fuze for Mining, and other Purposes.—A very simple and inexpensive fuze has recently been invented. It is made by doubling about five inches of thin copper bell wire, which has been coated with gutta percha, twisting about one inch of the looped end, and separating the extremities of the untwisted portions, so that the whole will be in the form of a two pronged fork, of which the twisted part forms the handle. The top of the twisted part being then cut off, the severed portions of the cut end are so near each other, that, when the free ends are connected with an induction coil of very small power, sparks will pass between them. The cut end is then placed in the open extremity of a small oblong capsule formed of very thin sheet lead, and containing a mixture which has been made by triturating ten parts by weight gunpowder such as used for fowling, and one part charcoal made of spindle-tree wood, the mixture having been previously moistened with ordinary collodion. When the cut end of the twisted wire has been inserted in the capsule, the lower edge of the latter is to be fastened to the former, by means of thick gum lac varnish. The smallest spark passing between the cut ends of the twisted wire will ignite the composition in the capsule, and this will ignite any explosive substance in which it may have been placed.

New Galvanic Battery.—The notice of the Academy of Sciences has recently been drawn to a battery of a new kind, which is said to have acted extremely well, for electrotype purposes, during several months. It is founded on the fact that aqua regia will not dissolve perfectly pure silver; it merely covers the silver with a thin coating of chloride, that protects it completely from further action, so that it may be immersed for an indefinite period in the aqua regia, without undergoing further change. If the silver contains copper, or the aqua regia has been made with an excess of nitric acid, or even with equal quantities of nitric and hydrochloric acids, the silver will, to a greater or less extent be changed into a chloride. Two-thirds hydrochloric and one-third nitric acid, or three-fifths of the former and two-fifths of the latter were found to answer well. The battery was a Grove-Bunsen formed of silver, aqua regia, zinc, and sulphuric acid diluted as usual. After having been in action for some months, the silver was not found to have lost any perceptible weight, nor was there any chloride in the porous vessel containing the silver and aqua regia.

A Very Simple Electrical Machine.—This machine is an improvement on that of M. Holtz. It consists of a disc of strong paper, 30 centimetres in diameter, mounted on an axis made of glass tube or some other non-conducting material, and capable of being made to revolve about fifteen times in a second, by means of wheels, an endless band, and a handle. In front of the disc are two metallic rods having pointed extremities which are perpendicular to the disc, being turned towards it, and at equal distances from its centre. The remaining portions of the rods are bent perpen-

dicularly, one up and the other down, so that the metallic balls on their other extremities may be at an adjustible distance from each other. The apparatus is charged by placing a sheet of paper that has been well dried at the fire and electrified by friction, very near, but not in contact with the disc, opposite to one of the pointed collectors, but not at the same side of the disc. On turning the machine, a luminous jet will pass between the balls. If the disc is covered with gum lac, and sheets of paper oppositely electrified are placed opposite the points of the collectors—one sheet being opposite to each collector—the intensity and duration of the effects obtained will be greatly increased. When the experiment is carefully made, sparks, five centimetres in length, will pass between the balls, and a Leyden jar, the coatings of which are connected, respectively, with the latter, will be charged with great rapidity.

LITERARY NOTICES.

Diarrhœa and Cholera; their Nature, Origin, and Treatment, through the Agency of the Nervous System. By John Chapman, M.D., M.R.C.P., M.R.C.S. Second Edition, enlarged. (Trübner and Co.)—We have on a former occasion mentioned Dr. Chapman's treatment of cholera by the application of ice-bags to the spine. He founds this practice upon a theory which is at any rate plausible; and as medical treatment of this terrible disease has in the main proved a lamentable failure, he is entitled to make a strong demand for the trial of his plans. Diarrhœa and cholera he regards as substantially the same disease, arising from over-excitement of nervous centres, and remediable by diminishing the action of the particular nerves supposed to be over-stimulated. He is as unable as other members of his profession to give us any intelligible account of how and why excessive heat, great changes of temperature, impure water, etc., combine to generate cholera in some seasons more than others; but he has brought together a considerable mass of information which tends to increase disbelief in the value of the ordinary treatment, if it does act with equal power in creating faith in ice. Opium, stimulants, calomel, and sulphuric acid are among the agents which Dr. Chapman considers positively mischievous. The effect of the ice treatment applied to the *spine only* is illustrated by numerous cases, and when accompanied by warm drinks, is affirmed to have been highly successful. The question is, has Mr. Chapman, in his zeal as a supposed discoverer, exaggerated the merits of his nostrum? We look to the medical world to answer this query by authentic cases, and a fair comparison of different methods. If Dr. Chapman is wrong, let his theory go the way to oblivion which previous errors have traversed—if right, let society have the benefit of it, whatever may be its consequences to medical orthodoxies.

Researches on Solar Physics. By Warren De La Rue, Esq.,

Ph.D., F.R.S., F.R.A.S.; BALFOUR STEWART, Esq., M.A., F.R.S., Superintendent of the Kew Observatory, and BENJAMIN LOEWY, Esq., Observer and Computer of the Kew Observatory. Second Series (in continuation of First Series). AREA AND MEASUREMENTS OF THE SUN SPOTS, observed by Carrington during the seven years from 1854 to 1860 inclusive, and deductions therefrom. (Taylor and Francis.)—To verify the observations of Carrington by comparing them where practicable with the Kew photograph was one part of the labours which are recorded in the "Second Series" of the *Researches on Solar Physics*, and then to ascertain what indications they afforded of the laws regulating the appearance and distribution of spots. The authors have constructed an elaborate table showing the proportion which the spotted area bore to the solar surface for each day on which an observation could be made between 1854 and 1860 inclusive. Another inquiry related to the distribution of spots on the disc of the sun, and from this it appears that the "average size of a spot varies with the ecliptical longitude, and there is a periodical recurrence in their behaviour, and the period of recurrence of the same behaviour appears to be nineteen or twenty months." "In all these recurrences the progress of the maximum is from left to right, not from right to left." "The period of twenty months," say the writers, will enable us to determine which of the inferior planets exercises the predominant influence on sun spots. We have to ask which of the two inferior planets takes twenty months to return to the same position with respect to the earth. This evidently points to Venus, for which the synodical period is 583 days, or between nineteen and twenty months." Jupiter appears also to affect the spots, and when both that planet and Venus are in opposition to the earth, large spots appear, and the average seems smaller when Venus is in opposition and Jupiter in conjunction. With reference to the position of the spots, "it would appear that spots are nearest to the solar equator when the heliographical latitude of Venus is 0°, and are most distant from the solar equator when the planet attains its greatest heliographical latitude."

The writers remark, "it is not to be inferred that the mechanical equivalent of the energy exhibited in sun spots is derived from the influencing planet, any more than it is to be inferred that the energy of a cannon ball is derived from the force with which the trigger is pulled. The molecular state of the sun, just as that of the cannon or of fulminating powder may be extremely sensitive to impressions from without. We may infer from certain experiments, especially those of Cagniard de Latour that at a very high temperature, and under a very great pressure, the latent heat of vaporization is very small, so that a comparatively small increment of heat will cause a considerable mass of liquid to assume the gaseous form, and *vice versa.*" From the preceding remarks and extracts it will be seen that the Second Series of *Solar Physics* is of high value. Is not their title awkward? "Researches *on* Solar Physics." We search *into* a matter. A search or research *on* the earth would be a search conducted *upon* it, not necessarily one into its elements or composition.

PROCEEDINGS OF LEARNED SOCIETIES.

GEOLOGICAL SOCIETY.—*December* 19, 1866.

The following communication was read:—

ON A NEW SPECIMEN OF TELERPETON ELGINENSE. By Professor T. H. Huxley, LL.D., F.R.S., V.P.G.S.—The specimen which was described in this paper had been broken into five pieces, exhibiting hollow casts of most of the bones of *Telerpeton Elginense.* It is the property of Mr. James Grant, of Lossiemouth, and came from the reptiliferous beds of that locality, along with some highly-interesting fragments of *Stagonolepis* and *Hyperodapedon.*

In describing these remains, Professor Huxley discussed especially the biconcave character of the vertebræ; the mode of implantation of the teeth, which he believed to be Acrodont, and not Thecodont; and the anomalous structure of the fifth digit of the hind foot, which presents only two phalanges (a proximal and a terminal), a structure which differs from that of all known Lacertilian reptiles, whether recent or fossil. His researches had led him to conclude that the animal is one of the Reptilia, and is devoid of the slightest indication of affinity with the Amphibia. In all its characters it is decidedly Saurian, and accords with the suborder *Kionocrania* of the true Lacertilia; but the author had not been able to make sure that it possessed a columella. He also remarked that the possession by *Telerpeton Elginense* of vertebræ with concave articular faces does not interfere with this view, as although most recent Lacertilia have concavo-convex vertebræ, biconcave vertebræ much more deeply excavated than those of *T. Elginense* are met with among the existing Geckos.

Professor Huxley, in conclusion, drew attention to the interesting fact that *Telerpeton* presents not a single character approximating it towards the type of the Permian *Protorosauria*, or the Triassic *Rhynchosaurus*, and other probably Triassic African and Asiatic allies of that genus, or to the Mesozoic Dinosauria; and that whether the age of the deposit in which it occurs be Triassic or Devonian, *Telerpeton* is a striking example of a *persistent type* of animal organization.

NOTES AND MEMORANDA.

TEMPEL'S COMET AND SHOOTING-STARS.—Dr. Peters, of Altona, writing in *Astronomische Nachrichten,* points out the close resemblance between the orbits of the August and November meteors, and that of Tempel's comet. He states that further observation is necessary to show whether this comet really belongs to that system of small bodies, and remarks that it is distinguished from other comets of short periods by its retrograde motion.

FAYE ON THE SUN'S ROTATION.—*Comptes Rendus,* No. 5, 1867, contains an elaborate paper founded on Mr. Carrington's observations. He arrives at the following conclusions:—"1. The retardation of the rotation of the photosphere from one parallel to another is proportional to the square of the sine of the latitude. 2. The constant of the parallax of depth applicable to observations of

spots is 0°·41: the depth of the spots is the shene of 0°·30 or of 0°·57 the radius of the earth. It is constant through the whole extent observed between +30° and —30° of latitude. 3. Spots have a pendulum-like oscillation in latitude: the period of these oscillations varies with the latitude, and appears to reach a maximum of 150 to 160 days about the 14th degree. At 15 degrees from that point it seems reduced about one-half. 4. Spots have an oscillating motion in longitude corresponding with the same period, and the geometrical combination of these movements operates as if the spot described in the direction of the rotation an ellipse about its mean position, with its major axis directed from one pole to the other. This singular rotation appears to have a direct connection with the internal constitution of the sun."

Mr. Wray's Object Glasses.—Mr. Wray, of Clifton Villas, Highgate Hill, recently brought before the Astronomical Society an account of his plans for correcting the secondary spectra in object-glasses. He interposes "a thin meniscus film of highly dispersive cement" between flint and crown glasses, and thus obtains a perfect achromatic image.—*Monthly Notices*, January.

Phantom Thumbs.—If any one looks steadily at a patch of moderately bright light on a wall, and then gradually raises his hands, having the fingers shut, the palms directed forwards, and the two thumbs touching at their tips, he will at the moment the thumbs reach the level of the eye, see *three* thumbs instead of two. The eyes should be directed steadily at the wall all the time, and not attempt to look at the thumbs. Some persons see the illusion best when the thumbs are within a few inches of the eye, and others do so when they are held away at arm's length. Curious effects are produced by slowly separating the thumbs as they reach the eye-level, and also by substituting fingers for thumbs.

Bees' Eggs and their Products.—M. H. Landois, in *Comptes Rendus*, recites experiments he made to test the truth of the proposition laid down by Dzierzon and Von Siebold that working bees are hatched from eggs which the queen fertilizes with sperms from her *receptaculum seminis*, while male bees issue from eggs not so fecundated. By carefully removing eggs from cells destined for the workers to those of the males, and *vice versa*, he altered the nature of their inmates. Thus, he says, the difference of the food supplied to the inhabitants of the two kinds of cell determines whether they will be males or workers.

Plateau's Liquid.—For blowing the large persistent bubbles and exhibiting experiments with films, M. Plateau states that pure oleate of soda dissolved with gentle heat in distilled water, in about 40 of water, and then mixed with Price's Glycerine, in the proportion of 3 parts of the oleate to 2·2 glycerine, gives the best results. The mixture is fit for use one or two days after it has been made. Bubbles blown with this liquid have lasted longer than twenty-four hours. The fluids usually sold in London for these experiments are great rubbish. Some respectable chemist should prepare the pure oleate.

Boiling Water in Rotation.—M. Mousson wished to keep some water boiling for several hours in a large glass globe with a flat bottom holding about three *litres*, and heated with gas. The ebullition was weak, although facilitated by copper turnings unequally distributed over the bottom of the vessel. Occasional vapour bubbles preserved their dimensions uniform in their passage through the liquid, showing the equal distribution of the heat. In order to make the copper turnings assemble together above the flame he caused the vessel to rotate. This immediately gave rise to an energetic whirlpool movement about the axis of rotation, a sort of water column eight to ten millimetres in diameter revolving rapidly, carrying up multitudes of copper particles. In the midst of this column was a constant disengagement of small bubbles, closely approximating, and making a momentary canal one millimetre in diameter. No bubbles proceeded from other parts of the liquid. *Kleine Physic, Mittheil. Archives des Sciences.*

ECONOMIC USE OF SHELLS.

cherd from a rare Japanese work in the British Museum
Cameo cut upon it in the British Museum shell galle

THE INTELLECTUAL OBSERVER.

[illegible] 1867.

[illegible] SHELLS, AND THEIR INHABITANTS.

(With [illegible])

BY HENRY WOODWARD, F.G.S., F.Z.S.,

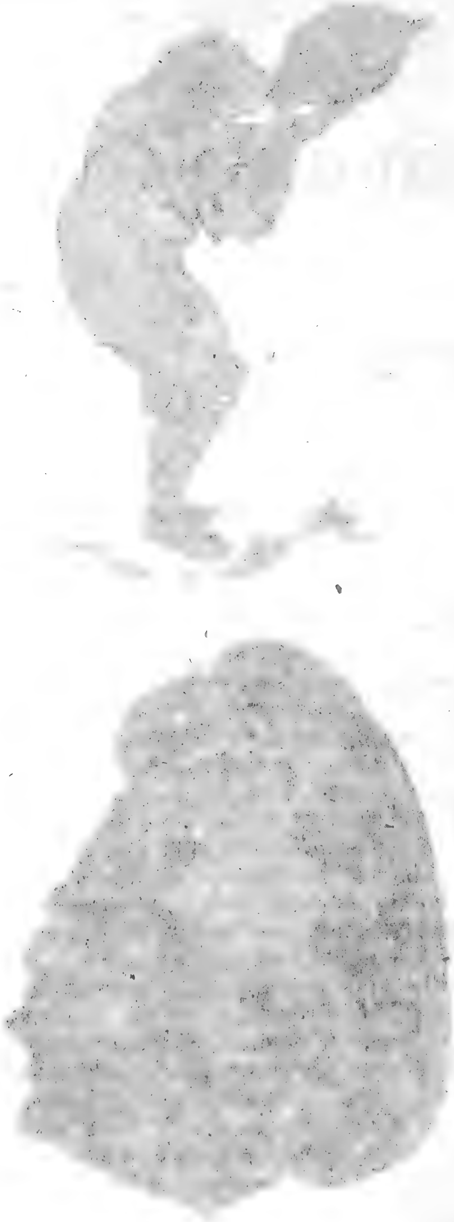
[illegible] the British Museum.

In the two former articles which appeared in the INTELLECTUAL OBSERVER (vol. x., No. [illegible], November, 1866, pp. 24[illegible]–253, and vol. xi., No. 4., [illegible] 1867, [illegible]) some account of the [illegible] and Construction of Shells," with illustrations [illegible] wonderful differences which the mollusc [illegible]

[illegible] dwelling [illegible] valves, associated [illegible] in opening them; [illegible] univalves, and [illegible] shell to procure [illegible]

[illegible] impel them to seek [illegible] the limestone [illegible] of [illegible] shells of molluscs [illegible] with holes, for the purpose of [illegible] day [illegible] the same [illegible] uses of [illegible] to throw much [illegible]

[illegible]



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ECONOMIC USES OF SHELLS, AND THEIR INHABITANTS.*

(*With a Tinted Plate.*)

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In the two former articles which appeared in the Intellectual Observer (vol. x., No. iv., *November*, 1866, pp. 241—253, and vol. xi., No. i., *February*, 1867, pp. 18—30,) I gave some account of the "Form, Growth, and Construction of Shells," with illustrations of the most remarkable diversities which the mollusca present. I propose now to speak of the economic uses to which man has applied this class.

At almost the earliest period in which we discover evidence of the existence of man, we find the primitive races dwelling upon the sea-shore, and subsisting largely upon mollusca; leaving at one point shell-mounds of oyster-valves, associated with rudely-fashioned flint knives, employed in opening them; at another, the broken fragments of turbinated univalves, and the round stone hammers used in crushing the shell to procure the *bonne bouchée* it enclosed.

Nor did the mere cravings of hunger impel them to seek shell-fish as articles of food, for in the limestone caverns of France and Belgium numerous remains of shells of mollusca have been met with, pierced with holes, for the purpose of attaching them to some article of dress or head-gear.

Among the aborigines of the present day, in whatever region of the earth they dwell, the same economic uses of mollusca prevail, and their practices serve to throw much light upon the fragmentary remains of their pre-historic ancestry.

Shell-fish as articles of food.—No shell-fish has, probably, endured more severe havoc from mankind than the common

* From the Notes of the late Dr. S. P. Woodward, F.G.S., etc., and other sources.

oyster; for it is only in comparatively late years that it has received the protection of Mr. Frank Buckland, and become a subject for Parliamentary committees to discuss, and Government to legislate for.

The shores of Denmark and her islands are marked to this day by vast shell-mounds (kjökken-möddings), indicating the primitive taste for *Ostrea edulis*. No doubt vast strata of oyster-shells must exist beneath London, when we consider that from 20,000 to 30,000 bushels of "natives," and 100,000 bushels of "sea-oysters," were (ten years ago) annually supplied to the London market. If any falling off has occurred of late in the former kind, the latter have, no doubt, been brought in larger quantities to meet the demand. The Oyster Companies promise to make oysters as cheap as ever in another six or seven years. "Sea-oysters" (*i. e.*, oysters naturally grown) attain their majority in four years, but "natives" (*i. e.*, oysters artificially cultivated) do not reach their full growth in less than five or seven years. It was the bringing of immature oysters to market which has, to a great extent, produced the present scarcity of this article of food. Many other species of oysters are eaten in India, China, Australia, etc.

Pecten maximus—commonly known as "scallops" in the London market, "queens" at Brighton, and "frills" on the coasts of Dorset and Devonshire—are now almost as much eaten as oysters, but they require to be cooked first.

An allied species has received the name of "St. James's shell" (*Pecten Jacobæus*); it was worn by pilgrims to the Holy Land. The fossil Pectens found in the sub-apennine formation of Italy were supposed by early writers to have been dropped by these devout persons on the road. Parnell says of the hermit:—

> "He quits his cell; the pilgrim staff he bore,
> And fixed the *scallop* in his hat before."

The aged Pectens certainly are sedentary in their habit, as is testified by the mass of *Bryozoa*, *Serpulæ*, *Alcyonium*, and *Balani* attached to their upper flat valve. They do not, however, fix themselves like the oysters by the deep valve, but some species are moored by a byssus to stones, or the stems of the *Laminaria*.

The young Pectens swim freely by rapidly closing and opening their valves. The writer, when dredging with Mr. MacAndrew off Coruña, has seen *Pecten opercularis*, two inches in diameter, swim rapidly out of the dredge as it was hauled up alongside the boat.

Mytilus edulis, the common edible sea-mussel, although far less highly esteemed than the scallop or oyster, is nevertheless much in request as an article of food.

I have not been able to ascertain the consumption of mussels in London, but in Edinburgh and Leith it is estimated at 400 bushels annually. Dr. Knapp states that from thirty to forty millions are collected yearly in the Firth of Forth alone, and used as bait for the deep-sea fishery. They form no small item of consumption in the north of Ireland; boats-full being constantly sent to the Belfast market.

The common cockle (*Cardium edule*) is largely used in many parts of England for food. It is obtained at extreme low water on all sandy shores, living buried beneath the sand.

Many other species of bivalve mollusca are eaten abroad; for example, in North America, "hard" and "soft clams" (*Mya* and *Lutraria*); whilst the giant clam (*Tridacna gigas*) of the Indian Ocean, the shell of which often weighs upwards of 500 lbs., contains an animal weighing sometimes 20 lbs., which is stated by Captain Cook to be very good eating.

The Mactras are eaten by the star-fishes and whelks, and in the Island of Arran *Mactra subtruncata* is collected at low water to feed pigs upon.

Gnathodon cuneatus—a shell nearly allied to *Mactra*—was formerly eaten by the Indians.

The Solens, or "razor-fishes," are excellent articles of food when cooked.

The *Patella*, or rock-limpet, is much used by fishermen for bait. On the coast of Berwickshire nearly twelve millions have been collected yearly, until their numbers are so decreased, that collecting them has become tedious. In the north of Ireland they are used for human food, especially in seasons of scarcity. Many tons weight are collected annually near the town of Larne alone. (*Patterson.*)

The "oyster-catcher" (*Haematopus ostralegus*), a well-known sea-shore bird, does not subsist upon the oyster, as its name implies, but chiefly upon the *rock-limpet*. The adroitness which he displays in undermining these, far exceeds the rapidity of the most practised oyster-opener at a London fishmonger's.

The *Haliotis* abounds on the shores of the Channel Islands, where it is called the "Ormer," and is cooked, after being well beaten to make it tender. It is also eaten in Japan.

The whelk (*Buccinum*) is dredged for the market, and is also used as bait by fishermen. Many tons' weight of whelks are annually consumed in the streets of the poorer parts of London.

The "buckie" (*Fusus antiquus*) is extensively caught in Scotland for the markets, being more highly esteemed than the *Buccinum*. It is the "roaring-buckie," in which the sound of the sea may always be heard.

The *Litorina litorea* is collected in immense quantities around our shores, and is known by the familiar name of "winkles," or "pin-patches." This species is oviparous, and inhabits the lowest zone of seaweed between tide-marks. The *Litorina rudis* frequents a higher region, where it is scarcely visited by the tide; it is viviparous, and the young have a hard shell before birth, in consequence of which the species is not eaten.

Both the *Litorina* and *Trochus* are the food of the thrush, in the Hebrides, during winter.

The *Amphibola*, a mollusk allied to *Ampullaria*, is eaten by the New Zealanders.

The land-snails, such as the *Helix arbustorum*, and *H. aspersa*, are the favourite food of the blackbird and thrush, and a smaller species of *Helix*, common on sandy pastures, is said by Patterson to be eaten in vast numbers by the sheep when grazing, and to form a very fattening kind of food.

Another land-snail (*Helix pomatia*) was highly esteemed by the Romans, who fattened them as articles of food; they are still found abundantly in many localities in the south of England, especially about the sites of old Roman villas in Gloucestershire. They were at one time appreciated by our ancestors, and when boiled in spring water, and seasoned with oil, salt, and pepper, they make a dainty dish.* Our neighbours the French still eat them extensively, as do also the poorer classes in Spain and Italy; the Brazilians also eat land-snails.

Everyone who visits the Paris Exhibition should taste a dish of snails; they are most delicious.

The flesh of the Cuttle-fish, especially that of the arms, is considered highly nutritious. It was greatly prized by the ancients, and, though not used in this country, is still much sought for in other parts of the world, and regularly exposed for sale in the markets at Naples and Smyrna, and the bazaars of India. In the curious Japanese book, from which Fig. 1 of our Plate is taken, there is a picture of a man in a boat engaged in catching cuttle-fishes with a spear, and also of a fishmonger's shop in Japan, at which a number of enormous cuttle-fishes are represented hanging up for sale. The writer has seen three species of cuttle-fish exposed in the markets of Santander, Coruña, and Gibraltar, viz., *Onychoteuthis Banksii*, Leach., *Sepia officinalis*, Linn., and *Loligo vulgaris*, Lam.

Our most common species (*Loligo vulgaris*) forms the bait with which one half of the cod taken at Newfoundland is caught. It is also commonly used for bait by the Cornish fishermen. (*Couch.*)

From their pelagic habits, they furnish the principal part

* Gray's *Turton's Manual*, pp. 135-6.

of the food of the dolphins and cachalots, as well as of the albatross and larger petrels.

My friend, Mr. R. Warington, of Apothecaries' Hall, has informed me that the test of the genuineness of "spermaceti," as imported, is, that it is full of the undigested beaks of the calamary, upon which the sperm-whale feeds.

The undigested remains of fossil cuttle-fishes are frequently noticed entombed within the ribs of the *Ichthyosauri* and *Plesiosauri* of our Lias, showing that then, as at the present day, to eat, and to be eaten, was the general law of nature.

Having briefly pointed out a few instances of the manner in which the mollusca subserve the good of mankind as articles of food, I will now proceed to speak of the various other uses to which they have been applied in medicine, commerce, the arts, and manufactures.

Shells used in Medicine.—In the *Pharmaceutical Journal* for February, 1862, my friend, Mr. Daniel Hanbury, F.L.S., published some interesting "Notes on Chinese Materia Medica," from which I extract the following:—

"*Shih-keue-ming*; shells of *Haliotis funebris*, Reeve; *Puntsaou*, Fig. 969, etc. This shell is stated to occur on the coasts of Fuh-kien and Kwantung. Messrs. Cuming and Lovell Reeve (both since deceased), who have examined it, concur in referring it to *Haliotis funebris*, a New Holland species figured by the latter gentleman, in his beautiful *Conchologia Iconica*, sect. *Haliotis*, pl. xii., f. 38.

"*Shih-yen*; Fossil shells; Tàtarinov. *Cat. Med. Sinens.*, p. 54; *Puntsaou*, Fig. 65. These fossils have been examined and described by Mr. Thomas Davidson, to whose account and figures, in the *Proceedings of the Geological Society* (June 15th, 1863), I refer the reader who wishes for full details. The actual specimens are in the British Museum. Mr. Davidson remarks that the specimens belong to eight Devonian species, seven of which are common to several European localities, among which may be mentioned Ferques and Néhou (France), Belgium, and the Eifel, but they are not found all existing together in any one of these localities. In external aspect the Chinese specimens most resemble those from Ferques, where, however, two of them, *Cyrtis Murchisoniana* and *Rhynchonella Hanburii*, have not yet been discovered.

"If to these be added two described by M. de Koninck, the total number of Chinese Devonian types at present known will amount to ten species, viz.:—3 of *Spirifer*, 2 of *Rhynchonella*, 1 *Productus*, 1 *Crania*, 1 *Cornulites*, 1 *Spirorbis*, and 1 *Aulopora*. These fossils are asserted to occur in the southern province of Kwang-si, where coal is also met with"

Onycha—*Blatta Byzantina.*—In old Pharmacopeia an article

is described from the Levant under the name of "*Blatta B.*"* Dr. Lister laments the loss of this article from the *Materia Medica,* believing it "to have been a good medicine, from its strong aromatic smell." Mr. Hanbury procured samples in Damascus in October, 1860, and a friend bought some in Alexandria a few months before. This oriental drug is still found in the bazaars of the East, though not much in demand.

It appears to be identical with the *Onycha* of Scripture (Exodus xxx. 34), one of the ingredients of the sacred perfume (W. Smith, *Dict. Bib.* iii. 635). *Dioscorides* describes the onyx (*Onycha*) as the operculum of a shell-fish, resembling *Purpura,* found in India; the best kind was obtained from the Red Sea. (*Pliny.*)

It really does consist of the horny opercula of whelks (*Purpura* and *Murex*), mixed with opercula of a species of *Fusus* and of *Strombus* (*lentiginosus*?), called by the Arabs "devils' claws," on account of their serrated edges. It does not appear to deserve the character of an "excellent odour" ascribed to it.

Humboldt tells us that the small operculum of a species of *Turbo,* flat on one side, and round on the other, has long been regarded by certain races of South America as possessing supernatural properties.

The "sea-hare" (*Aplysia depilans*) was formerly held in great dread among the superstitious fishermen of our coasts. It was said that its touch would cause the hair to fall off, and that the purple fluid it emits when touched was a deadly poison, the operation of which was inevitable. (*Patterson.*)

Mollusca applied in Commerce, Arts, and Manufactures.—All the cuttle-fishes possess an ink-bag, from which at pleasure they can emit a fluid which darkens the water, and favours their escape from their enemies. The prepared ink of the cuttle-fish is capable of being made into a pigment. This is the "sepia" of commerce.

The ink of the *Sepia* was formerly used for writing with (*Cicero*), and even after being entombed for centuries, it preserves its powers.

Dr. Buckland supplied some of this ink from a fossil *Belemnoteuthis* to an eminent painter, who, after using it, inquired from what colourman such excellent sepia might be procured. But "sepia" is not the only colouring matter which the mollusca furnish for the use of man. The dye used in the manufacture of the celebrated "Tyrian purple" of the ancients was obtained from certain species of *Murex.* The small shells were bruised in mortars, and the animals of the larger ones

* See Matthiolus' *Comment in Diosc.*, ii., 8, figures of *Blatta B.* also in Pomel's *Hist. des Drogues*, 1694.

were taken out. Heaps of broken shells of *Murex trunculus,* and cauldron-shaped holes in the rocks, may still be seen on the Tyrian shore. On the coast of the Morea there is similar evidence of the employment of *Murex Brandaris* for the same purpose. Many species of *Purpuræ* likewise produce a fluid which gives a dull crimson dye.

One of the earliest uses to which the shells of mollusca appear to have been applied was that of articles of dress.

In M. M. Lartet and Christy's *Reliquiæ Aquitanicæ* (Part iii. August, 1866. B., Pl. v., figs. 15—20), we find illustrations of several shells, viz., *Cypræa pyrum, Pectunculus glycimeris, Arca Breislaki,* which show clearly, by their having been perforated, that they had been worn either as ornaments or charms by the aborigines who inhabited the cavern of La Madelaine. The custom of using shells, etc., as necklaces, or other personal decorations, is common, not only amongst savages, but even amongst *civilized* races at the present day. In this case the shells have been obtained *not from sea or river,* but from the Faluns of Touraine or Bordeaux, deposits of Miocene age, rich in fossil marine shells, many of which are so well preserved as to retain the glazed surface seen in recent specimens. Dr. Fischer, of Paris, has determined as many as five species in the caverns of Perigord.

It is interesting to record, that in the cavern of Bruniquel, department Tarne et Garonne, an Oolitic Belemnite, having its sides squared by grinding, was found among the *debris;* also an Ammonite and a *Gryphæa,* probably introduced by children as toys. Perforated recent marine shells were likewise numerous. These relics are preserved in the British Museum. Shells are at the present day as greatly in demand for ornamental purposes as in pre-historic times.

The Chinooks of Oregon ornament their noses and ears with shells of *Dentalium.*

The Friendly and Fiji islanders wear the orange cowry (*Cypræ aurora*) as a mark of chieftainship.

The natives of Flinders Island and the New Zealander polish the *Elenchus* into an ornament more brilliant than the "pearl ear-drop" of classical or modern times.

Cypræa shells are worn as a head-dress by the natives of New Guinea.

The time would fail in which to tell all the various methods used in applying shells as ornaments to the head, dress, and person. Every book of travels in Africa, America, or to the South Sea Islands, teems with such illustrations. Nor does India furnish an exception to the rule; for there the female children have their arms and ankles, from infancy, encircled with broad shell-bands cut from the whorls of the great

Turbinella pyrum, and our Sepoy troops wear necklaces made from the canal of the same shell, as part of their parade uniform! (See Indian Museum Collection, Whitehall.)

One very ancient use of shells was as a medium of currency, and among certain tribes this custom remains in force even at the present day. In Oregon the currency consists of strings of the shells of *Dentalium.*

Some of the North American Indians used to make coinage (*wampum*) of the seaworn fragments of *Venus mercenaria,* by perforating and stringing them on leather thongs.

The money-cowry (*Cypræa moneta*), is a native of the Pacific and Eastern seas. Many tons' weight of this little shell are annually imported into this country, and again exported for barter with the native tribes of Western Africa. In the year 1848 sixty tons of the money-cowry were imported into Liverpool.

The use of turbinated or spiral shells as trumpets or horns to sound an alarum with, appears to be of most ancient date, and cosmopolitan in extent. The practice is followed among the African aborigines, the natives of the Eastern Archipelago, and New Zealand, and, according to the Japanese picture which we reproduce in our Plate (Fig. 1), it is followed in Japan at the present day.

"The sound of the trumpet or shell (writes Ellis), a species of murex (*triton*), used by the priests in the temple, and also by the herald, and others on board their fleets, was more horrific than that of the drum. The largest shells were usually selected for this purpose, and were sometimes above a foot in length, and seven or eight inches in diameter at the mouth. In order to facilitate the blowing of this trumpet, they made a perforation, about an inch in diameter, near the apex of the shell; into this they inserted a bamboo cane, about three feet in length, which was secured by binding it to the shell with finely-braided cinet; the aperture was rendered air-tight by cementing the outsides of it with a resinous gum from the bread-fruit tree. These shells were blown when any procession marched to the temple, at the inauguration of the king, during the worship at the temple, or when a tabu, or restriction, was imposed in the name of the gods. We have sometimes heard them blown. The sound is extremely loud, both the most monotonous and dismal that it is possible to imagine."* Specimens of these may be seen in the Shell Gallery, and also in the Ethnographical Room at the British Museum.

Shell-Cameos.—The fountain-shell of the West Indies, *Strombus gigas,* L., is one of the largest living univalve shells, weighing sometimes four or five pounds; its apex and spines

* *Polynesian Researches,* vol. i., p. 283.

are filled up with solid shell as it becomes old. Immense quantities are annually imported from the Bahamas for the manufacture of cameos, and for the porcelain works; 300,000 were brought to Liverpool alone in the year 1850.

The queen-conch (*Cassis Madagascariensis*), and other large species, are also used in the manufacture of shell cameos.

The best shell for cameo-engraving is the *Cassis rufa*, Brug., from West Africa. This is the species, with the cameo cut upon it, represented at Fig. 2 in our Plate. It was drawn by the late Dr. S. P. Woodward, from a specimen preserved in the Shell-Gallery of the British Museum, where many other illustrations of the economic uses of shells may be seen. The secret of cameo-cutting consists simply in knowing that the inner stratum of porcellanous shells is differently coloured from the exterior. Cameos in the British Museum, carved on the shell of *Cassis cornuta*, are white on an orange ground; on *C. tuberosa* and *Madagascariensis*, white upon dark claret colour; on *Cassis rufa*, pale salmon-colour on orange; and on *Strombus gigas*, yellow on pink.

The conversion of shells into receptacles for various things (both sacred and profane) should not be lost sight of here.

Some specimens of *Turbinella rapa*, from the Malabar coast, are exhibited in the Shell-Gallery. They have been carved externally, and scooped out internally, and were used, says Sir J. Emerson Tennant, to contain the sacred oil, employed in anointing their priests.

In Zetland, the *Fusus antiquus*, suspended horizontally by a cord, is used as a lamp, the canal serving to hold the wick, and the body of the shell the oil.

On the western coast of South America, there is a limpet which attains the diameter of a foot, and is used by the natives as a basin.

But perhaps the most amusing piece of native adaptation is an *Achatina* shell from Africa, which an ingenious native has fitted with a plug, and used as a snuff-box! (British Mus. Coll.)

Numberless are the applications of shells as sinks to nets, barbs to harpoons, and hooks, and in one case to make an artificial bait to catch cuttle-fishes with.

In Ellis's *Polynesian Researches*, vol. ii., p. 292, he gives an account of fishing for cuttle-fish with an artificial bait, formed of a piece of hard wood, to which a number of the most beautiful pieces of the cowrie, or tiger-shell, are fastened one over another, like the scales of a fish or the plates of a piece of armour, until it is about the size of a turkey's egg, and resembles the cowrie. It is suspended in a horizontal position by a strong line, and lowered by the fisherman from a small canoe until it nearly reaches the bottom. The fisherman continues

gently to jerk the line, when the cuttle-fish, attracted by the appearance of the cowrie, darts out one of its arms, which it winds around the shell, and fastens among the openings in the plates. The jerking being continued, the fish puts out another and another arm, till it has quite fastened itself to the shell-bait, when it is drawn up into the canoe and secured.

Pearl-producing shells.—The pearl-mussel, *Unio margaritis ferus,* afforded the once famous British pearls. It is found in the mountain streams of Britain, Lapland, and Canada, and is used for bait in the Aberdeen cod-fishery. The Scotch pearl-fishery continued till the end of the last century, especially in the river Tay, where the mussels were collected by the peasantry before harvest-time. The pearls were usually found in old and deformed specimens. Round pearls, about the size of a pea, perfect in every respect, were worth £3 or £4. An account of the Irish pearl-fishery was given by Sir R. Redding in the *Philosophical Transactions,* 1693. The mussels were found set up in the sand of the river-bed, with their open side turned from the torrent; about one in a hundred might contain a pearl, and one pearl in a hundred might be tolerably clear.

Hyria is the shell which the Chinese employ to produce artificial pearls, by the introduction of shot, etc., between the mantle of the animal and its shell. A *Hyria* in the British Museum has a number of little josses made of bell-metal, now completely coated with pearl, in its interior.

Pearls are produced by many bivalves, especially by the oriental pearl-mussel (*Avicula margaritifera*). They are caused by particles of sand, or other foreign substances, getting between the animal and its shell; the irritation causes a deposit of nacre, forming a projection on the interior, generally more brilliant than the rest of the shell. Completely spherical pearls can only be formed loose in the muscles, or other soft parts of the animal. The Chinese obtain them artificially, by introducing into the living mussel foreign substances, such as pieces of mother-of-pearl, fixed to wires, which thus become coated with a more brilliant material. Similar prominences and concretions—pearls which are not pearly—are formed inside porcellanous shells. These are as variable in colour as the surfaces on which they are formed. They are pink in *Turbinella* and *Strombus;* white in *Ostrea;* white or glossy, purple or black, in *Mytilus;* rose-coloured and translucent in *Pinna.* (See specimens in Shell Gallery, British Museum.)

The pearl-fisheries of the Persian Gulf and Ceylon give employment annually to several hundred boats and many

thousand men. The entire amount of revenue derived from the pearl-fisheries of Ceylon in nine years (from 1828 to 1837) amounted, according to Mr. James Steuart, the Inspector of Pearl Banks, to £227,131, but it has since decreased very considerably.

The shells of nearly all the *Turbinidæ* are brilliantly pearly when the epidermis and outer layer of the shell are removed. Many of them are used in this state for ornamental purposes.

The shell of *Haliotis* is also much used for inlaying papier-mâché work, etc.

Nor have we yet exhausted the list of uses to which the mollusca are applied. In many districts where lime is scarce, shells are used instead. Vast quantities are thus consumed on the coast of Chili and Peru.

The *Cerithium* (*Terebralia*) *telescopium* is so abundant near Calcutta as to be used for burning into lime. Great heaps of it are first exposed to the sun, to kill the animals, and then burnt. In some places they are so plentiful as to be used for road making.

Sir Charles Lyell tells us there are banks of the dead shells of *Gnathodon cuneatus*, three to four feet thick, twenty miles inland. Mobile is built upon one of these shell-banks. The road from New Orleans to Lake Pont-Chartrain, a distance of six miles, is made of Gnathodon shells, procured from the east end of the lake, where there is a mound of them a mile long, fifteen feet high, and twenty to sixty yards in width; in some places it is twenty feet above the level of the lake.

If anyone should reflect upon the *Mollusca* as undeserving so much notice, and mention the *Teredo* as an instance of a destructive member of the class, let him read of the utility of another, the common mussel, in maintaining the long bridge of twenty-four arches across the Torridge river, near its junction with the Taw, at the town of Bideford in Devonshire. At this bridge the tide runs so rapidly that it cannot be kept in repair with mortar. The corporation, therefore, keep boats employed to bring mussels to it, and the interstices of the bridge are kept filled with mussels. It is supported from being driven away by the tide entirely by the strong threads of the byssus which these mussels fix to the stonework.

The *Pinna* of the Mediterranean spins a byssus so long and fine that it is mixed with silk, and spun into gloves, caps, etc., at Taranto.

Although the British Museum collection has far higher claims upon the scientific man than upon the mere utilitarian, yet, as a large proportion of the visitors to that institution are *not* scientific, we cannot but feel indebted to Dr. Gray for the

very interesting and instructive series of specimens illustrating the economic uses of shells which he has caused to be exhibited there.

Explanation of Plate.

Fig. 1.—Japanese swine-herd blowing a Triton shell. Copied by the late Dr. S. P. Woodward from a rare and curious Japanese Book of Travels in Japan, preserved in the library of the British Museum.

Fig. 2.—Shell of *Cassis rufa,* with cameo (representing Raphael and Fornarina) engraved upon its surface. Drawn by the late Dr. S. P. Woodward from a specimen in the shell gallery of the British Museum.

The above have been carefully engraved by Mr. G. R. De Wilde, whose skill as an artist is well known.

FATIO ON FEATHERS—THEIR DECOLORATION.

In our December number (p. 377) we give an account of the important microscopical researches made by M. Fatio on the "Forms and Colours of Plumage," and we have now to complete the subject by further extracts from M. Fatio's paper.

M. Fatio commences a chapter on "Decoloration" by explaining the extravasation of pigment spoken of in the earlier part of his memoir. He says, "we have seen that in certain cases of coloration by change of colour, the first pigment, in a state of solution, was driven out by another and deeper pigment, and forced to extravasate itself; and we have also seen in other cases of coloration by augmentation of intensity, that the dissolved pigment diffused itself in the spaces produced by the absorption and evaporation of moisture, and that there was no extravasation until the coloration was complete. We can therefore understand that each colour, as well as each feather, has a limited duration while the bird is alive, and one colour, without being driven away by another, will nevertheless depart in its own turn. The feather which has performed its part succumbs under the efforts which it has made; its tissues deteriorate, and its pigment after being completely dissolved, disappears, driven away by fresh accessions of greasy matter."

"If a feather grown in the autumn does not fall in the spring, and is not able to undergo a fresh coloration, it must necessarily suffer a decoloration, more or less rapid and complete."

"If the tissues which are entirely filled with a coloured solution are able to distend themselves under the influence of moisture, no extravasation will occur until the new spaces are filled by the freshly dissolved pigment. But there is a limit to the cortical development of a feather, nearer or more remote. Optical feathers,* which possess most of this cortical substance, exhibit a later and less complete extravasation, while mixt feathers, possessing less of this substance, exhibit it more speedily."

"A young gull, *Larus ridibundus,* has in the summer a first plumage which is almost entirely brown, and in its first spring it is nearly all white, without any true moult having occurred in the greater part of its feathers. An observation of the plumage of this bird at the end of autumn discloses all the transitions between the two states of colour, and the microscope explains the cause of the transformation. The brown barbs and barbules are filled with a very diffused brown pigment; a brown dust covers the exterior of each part of the feather in proportion to the extent of the decoloration, not being seen on those which are quite brown or quite white. The decoloration pursues an opposite course to that of the coloration; it proceeds from the base towards the extremities, and from the centre to the periphery, instead of moving from the borders towards the middle of the feather. It is a continuous change of a colourless grease for a coloured pigment, of which at last only a little remains in the centres, giving a slight tint to the feather.

"Similar phenomena occur in most of our birds, and to such actions we must ascribe the case mentioned by Brehm of some starlings, in which a black colour was hidden under a white external dust." If we place under the microscope, between two pieces of glass, a feather in process of decoloration, and a drop of oil, the process may be seen going on, made more active by slight heat and retarded by cold.

"In spring, we often see young gulls whose white livery is much less advanced than that of others of the same age: they are individuals in which the decoloration commenced in the autumn has been arrested by the extreme cold. The deeper a feather lies, and the more it is sheltered, the more promptly extravasation takes place during the life of the bird. The grease proceeding from the bird's body produces a coloration from the periphery towards the centre, when it meets with pigment that is already dissolved, or tissues already filled, because only one exchange is possible; and the same grease produces a coloration from the periphery towards the centre, because it is at the extremities that it finds first, and chiefly,

* For an explanation of these terms, see the previous paper, Dec. No., p. 377.

the moisture and light which are necessary to effect a solution of the latent pigment. At the same time extravasation occurs in the hidden parts of the feather, likewise producing a decoloration towards the extremities moving in a contrary direction and encountering the other action."

"Of these two processes of decoloration, the second sometimes overpowers the first, and under certain conditions it sometimes happens that a feather becomes gradually decoloured from the summit to the base. As is the case with extravasation, the coloration is always more rapid in mixt feathers. The quickest coloration is most often due to abundance of the greasy matter in a bird, aided by favourable conditions of atmospheric moisture and temperature. The changes are also often rendered more striking by an exceptionally rapid fall of the fragile tips, which mask, while they remain, the transition that has taken place in adjacent parts." The occurrence of albinism, which is natural in some birds, may be accounted for by the accidental operation in others of the causes just explained.

M. Fatio thinks that under the influence of violent emotion an unusual influx of greasy matter may occur, and under suitable conditions of temperature and moisture, may give rise to a sudden appearance of albinism.

"The extravasated coloured dust must not be confounded with the true external colouring which the feathers of some birds exhibit. Many species of different orders show, in fact, accidentally or regularly on certain parts of their bodies, most frequently on their lower surfaces, different colorations, more or less concentrated, and more or less persistent, resulting from friction against certain mineral or vegetable bodies, of which they are particularly fond. This external painting has sometimes given rise to the creation of false species. It arises most frequently from the soil on which the bird lives, the food it obtains, and the kind of life it leads. M. Meves, in a memoir which was translated by Gloger, and inserted in the "Journal of Ornithology" (*Journal für Ornithologie*), studied the brown and orange coloration of the vulture (*Gypaetos*) of the south. He described this coloration as external, and capable of removal by an acid wash, and he attributed it to the repeated bathings of the bird in ferruginous springs. Eugene von Homeyer also noticed a brown external coloration amongst the cranes in their nesting time in the north, and he ascribed it to the marshy soil with which the birds covered themselves by means of their beaks. Meves has likewise noticed the same thing, and adds that it is perceptible (comes off?) when touched. Many ducks also acquire a rosy tint on the belly, from the vegetation on which they rest. Some small birds in like manner become of

variegated colours on their breasts and bellies, either from the materials of their nests, or from that of the hole which they inhabit. Thus in spring I have seen the *Parus borealis* almost completely red on its lower surfaces. Lastly, an external colour, attaching especially to the throat, sometimes arises from coloured food, as when the throat and breast of the nutcracker assumes a dark rust colour when, during the frosts, it comes down to the valleys and feeds greedily on the hazel-nuts, in which it delights."

CONCLUSIONS.

"I have pointed out the principal agents which modify feathers, and their mode of action. I have also shown how these same agents can sometimes produce varied effects under different conditions; and lastly, I have shown how a certain equilibrium between external and internal condition is necessary to keep the coloration of a species within typical limits."

"I cannot assert that I have foreseen all the divers causes of natural or accidental variation, nor can I pretend to have submitted to examination all the different feathers which birds may present. I have passed by some modifications purely ornamental; but I think I have investigated the most natural and ordinary forms, and that new phenomonon may easily find their explanation upon the principles thus disclosed."

* * * * * * *

"My explanation comprehends not only the variation of colours more or less striking according to locality and climate, but also the formation of race and varieties according to the prevalence of different conditions of moisture, temperature, and inclination."

SILVERED MIRROR TELESCOPES—THEIR MERITS AND DISADVANTAGES.

The introduction of silvered mirror telescopes in this country upon M. Foucault's plan, seems to have originated with amateurs. A London optician, indeed, exhibited a few years ago in his window a French pattern of small size in a square mahogany case, and at a price considerably beyond its merits, but it remained for Mr. Browning to make them, in an improved form, a regular article of trade. Mr. Webb, in our pages, was one of the first astronomers who directed the attention of English observers to the advantages arising from their construction, and to him belongs the merit of having introduced Mr. With's mirrors to general notice and admiration. Our readers will also recollect interesting communications from Mr. Bird, who constructed a large and fine silvered mirror telescope for his own use. A sufficient time has now elapsed since Mr. Bird, Mr. Cooper Key, and Mr. With turned their attention to these instruments, and since telescopes with mirrors made by the latter, and admirably mounted by Mr. Browning, have been in use, for some definite replies to be given to numerous inquiries concerning the merits and disadvantages of this construction.

Two facts are now established, first, that the mirrors produced by Mr. With leave nothing to be desired in point of accuracy of form. Weather permitting, and *their mounting being good*, they are on the whole more than equal to achromatics of the same aperture in point of dividing power and definition, and in point of light they approximate to achromatics much more closely than the older telescopes with mirrors of speculum metal, which are more easily affected, in an unequal manner, by changes of temperature. A $6\frac{1}{2}$-inch silvered mirror in fair condition has more light than a $5\frac{1}{2}$ achromatic, and readily divides stars which few achromatics of its own aperture will touch. Thus, Mr. Slack's $6\frac{1}{2}$ telescope on *good* nights has several times distinctly split γ^2 Andromedæ, with about 350, and this star is easy with Mr. Webb's $9\frac{1}{4}$. In the matter of cost the new telescopes afford a happy contrast to the enormous price of fine achromatics—the larger sizes can be had, with fine equatorial mountings, for a fraction of the cost of an achromatic object-glass capable of doing the same work.

The advantages of the silvered mirror instruments of the Browning and With construction are cheapness, short focal length, with corresponding facilities in use, absence of the chromatic errors, of refractors, and absence of spherical

errors, from Mr. With's extraordinary skill in giving them the true form. Beyond this, it may be stated that the cell mounting devised by Mr. Browning, and his method of supporting the plane mirror, or prism, secures permanent good performance in any position, and closely approximates the sort of definition of large stars to the neatness obtained by first class and moderate-sized refractors.

It is the disadvantages of the system that we are most often requested to elucidate, and we have waited for some time in order to estimate them as fairly as possible. First comes the question, Is it not troublesome to keep a silvered mirror telescope in order? and we answer, *Certainly not,* as they are made by Mr. Browning.

A badly-mounted refractor is a great nuisance, but it is nothing in abomination and vexation to a badly-mounted reflector, which will keep its owner in an optical purgatory of a most unpleasing kind. By making the mirrors of very thick glass, and mounting them in the cells figured in a former number, Mr. Browning's reflectors are much like achromatics, and indeed from the glass not being thinned off at the edges, as in the double convex lens of achromatics, the chance of flexure is much less. Mr. Browning's cell answers perfectly for sizes from 6½ to 10½, and would probably do well for bigger instruments, though *monsters* might require other special contrivances to guard against flexure. There is no difficulty in adjusting these telescopes if slightly deranged. The screws are very manageable, and the test of true adjustment very easy. The instrument would, of course not, be out of order when it comes from the maker, but if the mirror is taken out of the cell, and the prism or flat dismounted, a very few minutes will suffice to put both right again. The plan is to remove the glasses from a deep eye-piece, and look through the small hole left in the brass work at the prism, or plane mirror, with a Barlow lens interposed. The eye readily detects want of centering, and the motions to obtain it are simple and easily understood by inspection of the parts. Thus we do not see that any one accustomed to philosophical instruments need be at all afraid of the new reflectors on this ground.

Then comes the question of keeping the thin film of silver in order. On this matter we have made divers experiments, and incline to the simplest treatment—that of using the mirror as if it were a fine achromatic object-glass—covering it up when out of use, and leaving it alone, with a rare and occasional wiping. This remark applies only to telescopes sheltered in some moderately good observatory. If used out of doors, it would probably be advisable to take the mirror indoors in its

cell, and keep it in a box when out of use, in a dry, cool place.

We left a mirror in our telescope all through the damp, foggy, and rainy weather of last year, protected first by a cover over the mouth of the tube, and secondly by an American cloth case over the instrument, and very little harm was done to the silvering. During a series of thick murky fogs we left some pieces of silvered mica freely exposed in the observatory, and they soon exhibited rainbow colours, while the protected mirror displayed no tarnish. Constantly taking a mirror in and out is very troublesome, and has the disadvantage that the instrument is not ready for those sudden observations that are often successful in changeable weather. We were, therefore, anxious to find out what would be the result of the treatment mentioned, and it seems that a mirror so circumstanced and freely used on damp nights, if anything is visible, will keep its lustre with an occasional rubbing for a considerable time. Ours was very little the worse for a year's use, and would probably have lasted at least a year longer, but for a special purpose we washed the silvering off.

Having experimented on silvering these glasses, we can affirm that no one accustomed to chemical processes need be afraid of failure, though the best possible silvering, perfectly free from specks, is of course a work of skill. The probable defect of amateur silvering will be the occurrence of a few spots and specks quite unimportant to optical performance. There may also be a tendency of some parts to be weaker than others, and to give way first after a succession of rubbings. It is essential that no rubbing shall ever be administered unless the mirror is perfectly *dry*. If wet or damp, off comes the silver with a touch, though when dry it may be rubbed like a spoon.

It is useless to try the silvering process in very cold weather. A warm day is clearly the most favourable; excess of cold prevents the adhesion of the film. The re-silvering process is cheap, whether done by the amateur, or performed for him by Mr. With, and when the mirrors are packed in suitable boxes, they can travel without risk.

When the silver begins to go, fine cobwebby cracks appear, but they do no harm for many months; and even in the atmosphere of Birmingham, with its thousands of chimneys pouring out all imaginable smokes and vapours, Mr. Bird finds the silvering stand for a considerable time. London atmosphere, as we have found, is far less destructive than might be expected.

Among the disadvantages of the silvered mirror telescopes, must be reckoned that plague of all reflectors, chimney cur-

rents in the tube. These may be greatly diminished by two means—first, having the tube larger than the mirror; and secondly, using the telescope out of doors, or in a form of observatory, which permits a ready equalization of its internal temperature with that of the outer air. Small revolving domes, with narrow slits, maximize the difficulty, and in awkward states of the weather render satisfactory performance impossible. All sources of optical disturbance increase rapidly with the size of the instrument, whatever be its construction, and the larger sizes require the best conditions and the most care. Under the same circumstances of *disadvantage*, reflectors may be expected to work rather worse than refractors with close tubes, though the difference is slight.

With moderate sizes, in good weather, the chimney currents of the new reflectors are scarcely noticeable, but when bitter east winds blow through a warmer atmosphere, they become very troublesome, and on the same nights no refractors will perform well.

We cannot look upon silvered mirror telescopes as only *substitutes* for refractors. If they have certain peculiar disadvantages, they have also peculiar merits, and those who get used to them feel no desire to change. The inconveniences of refractors eight, ten, twelve, fourteen feet long, are very serious, while reflectors of equal power are manageable and handy. A revolving eye-piece is indispensable to comfortable working. With it there are no awkward positions for the observer; without it many that are painful and perplexing. It is a very difficult task to have all the adjustments so perfect that a rotation of the eye-piece effects no displacement of the image. The adjustments may be so good that stars of less than 1″ apart, may be readily divisible in all positions of the instrument, and yet the rotation of the eye-piece may produce changes in apparent declination and ascension. With given adjustments these errors will be constant, and do not practically interfere with equatorial *finding*.

We find a Barlow lens and lower eye-pieces, as a rule, better than deeper eye-pieces without it, and upon planets and delicate moon objects we prefer Mr. Browning's achromatic eye-pieces to the Huyghenian. A monster aplanatic of Horne and Thornthwaite works well with the Barlow on nebulæ or clusters, and on many large objects usefully without it.

Duly balancing advantages and disadvantages, we feel satisfied that the silvered mirror telescopes will prove an immense boon to astronomical observers. They bring within the reach of amateurs with moderate means, an amount of optical power and a perfection of optical work hitherto confined to a few first-class observatories; and if fine prisms are used

instead of silvered flats, no fault will be found with the colour of the objects viewed. A slightly tarnished flat, exaggerating the peculiar chromatic action of the silver film, gives an unpleasant reddening to white objects; a fine prism is quite satisfactory, but it must really be a fine one, for *very slight* errors in its planes, and especially in the plane of the hypotheneuse, will render good definition impossible.

Mr. Browning's pamphlet, *A Plea for Reflectors,* contains a mass of valuable information, which we commend to those in need of it.

CHEMICAL AIDS TO ART.

BY PROFESSOR A. H. CHURCH, M.A., F.C.S.,

Of the Royal Agricultural College, Cirencester.

Some of the recent applications of chemistry to the fine arts are so full of interest, and yet so little known in scientific and literary circles, that a brief description and explanation of them is sure to prove instructive and entertaining to many of the readers of the Intellectual Observer. The subject is, indeed, very extensive, and on this account we propose, in the present paper, to limit the discussion to a few processes connected with the ornamental and artistic use of metals. We shall select three processes, all comparatively of recent invention; of none of them, so far as we are aware, has any account been hitherto published. They, moreover, have the advantage of being easily illustrated in home-made experiments, by any of our readers who care to follow the instructions about to be given.

Let us begin with platinum, one of the least known of the "precious" metals. Precious it is for several reasons. Not that it is very beautiful in colour and lustre, for although it may be obtained nearly as white as silver, its appearance usually resembles that of pewter very closely; yet time and experiment have shown that it has most valuable properties. It never tarnishes, no ordinary flame, or fire, or furnace will melt it, most strong acids and many chemical salts do not dissolve or injure it; and, when you do get it to dissolve, its solution forms a most useful chemical test, or "reagent," as it is called. Since the year 1741, when platinum was first brought to Europe, under the name of platina, or "little silver," it has been employed for many different purposes. As it could not be worked like ordinary metals, the Russians,

who made coins of it, adopting the plan invented by the English chemist, Wollaston, submitted the powder of platinum, as obtained by the chemical treatment of the ore, to powerful pressure, and to repeated blows, and also to the influence of a very high temperature. By this process the powder or fine particles of the metal may be made to cohere into an uniform solid mass. It is thus that platinum is fashioned into crucibles for chemists, stills for the purification of sulphuric acid, foil, leaf, and wire for various useful purposes. But we really must not dwell further upon these interesting facts in the history of platinum, for our intention is to describe something newer and less known. We purpose giving the details of a very simple and beautiful process for covering other metals with a delicate film of metallic platinum, and so at once varying their appearance, and endowing them with one of the virtues of this metal, namely, incorrodibility.

We have before mentioned that although platinum does not easily dissolve in acids, it can be induced to dissolve by appropriate treatment. If a few grains of scrap platinum, which may be purchased at the rate of about twenty shillings the ounce, be warmed in a flask with a mixture of three parts of hydrochloric (muriatic) acid and one part of nitric acid (aqua regia), it will soon begin to disappear, dissolving in the acids with a red-brown colour, not unlike that of dark sherry. This liquid contains a compound of the metal platinum with the non-metallic element chlorine. This compound is generally called bichloride of platinum. It may be obtained in the solid form by drying up, at a gentle heat, the acid solution of the platinum scrap. This salt or compound of platinum, may be thus prepared—40 grains of the metal yielding about 68 grains of the bichloride; or it may be purchased at a very moderate price. It cannot, however, be used directly and without any further treatment for the purpose we have in view, namely, the plating (or, rather, platinizing) of various metals. The following directions will serve for the preparation of a suitable solution for this purpose:—Dissolve in one ounce of distilled water—

60 grains of bichloride of platinum and
60 grains of pure honey.

Add to the above solution three quarters of an ounce of spirit of wine, and one quarter of an ounce of ether. The mixed liquids, if not quite clear, must be filtered through a piece of white blotting-paper. The objects to be platinized, which may be of iron, steel, copper, bronze, or brass, are to be thoroughly cleaned by washing them in soda, then in water.

When they have been dried, they require heating over a lamp, to a heat below redness. For this purpose they may be suspended, by means of a fine wire, over a spirit or an oil lamp, in such a way as not to touch the flame. Suddenly, before they have had time to cool, the objects are to be completely plunged beneath the surface of the platinizing liquid. One immersion for a single minute generally suffices; but the process may be repeated if necessary, care being taken to wash and dry the pieces operated upon before re-heating them. The composition of the solution may vary considerably, and yet good results be obtained. Sometimes the addition of more honey improves it; sometimes the proportion of bichloride of platinum may be increased or diminished with advantage. Indeed, it will be found that the appearance of the platinum film deposited upon the objects may be altered by changing the proportion of the bichloride present. The solution may be used several times; gradually, however, it loses all its platinum, the place of this element being taken by the iron or copper dissolved off the immersed objects.

We may now appropriately mention a few examples where this platinizing process seems to furnish desirable results. Articles made of iron or steel—watch-chains, seals, sword-handles, keys, and similar useful or ornamental objects—are greatly improved in appearance, and, moreover, preserved from all chance of rusting, by this treatment. The colour of the platinum film is of a neutral greyish black, and it often shows at the same time a faint iridescence. Iron or steel which has been inlaid with gold or silver, forming what is known as damascened work, is greatly improved by platinizing. Neither the gold nor the silver are in the least degree affected, and they will be found to afford a better contrast with the colour of the platinized than with that of the original iron.* Other artistic applications of this process will readily suggest themselves: coins, medals, chains, and ornaments of brass and copper may be instanced as excellent subjects for experiment. If they have been partially gilt or silvered before treatment with the platinizing liquid, those parts only of the specimen which show the original metal will change in colour. In this way very beautiful and effective designs of gold on platinum,

* Iron which has become deeply rusted cannot be platinized by our process. In order, however, to preserve from further destruction objects of steel or iron having an archæological or artistic interest, a very excellent plan may be used as a substitute. The purest white paraffine is to be melted in a clean pan, and maintained at about the temperature of boiling water. The rusted and corroded specimens are to be immersed in this paraffine bath till they cease to froth from escape of moisture. They are then withdrawn, wrapped in blotting paper, and kept in a warm place till the excess of paraffine has been absorbed. The objects thus treated, while preserved from further decay, do not acquire that disagreeable greasy aspect which the varnish ordinarily used imparts.

or silver on platinum, may be formed, while in the case of gold, at all events, the groundwork metal of copper or brass would scarcely have shown an appreciable contrast of colour.

Let us now consider a second process, not altogether dissimilar to that just described, but in which silver instead of platinum is concerned. We have already referred to damascening, in which iron is inlaid with gold or silver by a purely mechanical process. The same result may, however, be attained with silver as the inlay, in a totally different manner. The hollows destined to receive the silver patterns are engraved or etched by acid in the iron or steel, but, instead of using wires of metallic silver to fill these hollows, a chemical compound of silver is employed. This compound is the nitrite of silver, and is easily prepared by adding pure nitrite of sodium, dissolved in water, to a solution of nitrate of silver. When no more precipitate falls on further additions of the nitrite of sodium solution, the pale straw-coloured substance, which is nearly pure nitrite of silver, is to be collected on a filter, a little cold water poured upon it, and then, while still moist, pressed into the grooves in the iron which have been prepared for its reception. Here it is permitted to dry, and, when it is perfectly free from moisture, the next step in the process may be taken. This step consists in heating the metallic plate or other object over a lamp or fire till the whole of the nitrous acid has been resolved into gases, which escape, and metallic silver, which is left behind as a spongy mass. With an agate or steel burnisher the whole of the lines of silver must be followed, using considerable pressure to force the metal into the grooves and lines, any superfluous silver being rubbed away with very fine emery-powder, or a fine pencil-like hone.

Many metals besides iron may be ornamented with beautiful designs in inlaid silver by means of the process just described. Among these may be named copper, brass, and bronze; even gold and platinum admit of similar treatment. In all cases an easy method of etching out the hollows of the design is applicable. Both sides of the plate to be inlaid are covered with a resisting composition (beeswax melted with a little spirits of turpentine), the designs are boldly drawn, so as to lay bare the metal, and then the prepared object is to be immersed in the etching fluid. Weak nitric acid answers for all the common metals we have before named. When the design has been etched to a sufficient depth the object is withdrawn from the acid, and (after removal of the composition by means of spirits of turpentine) passed through the flame of a spirit-lamp, to burn off the last traces of the wax and turpentine.

This new process of inlaying silver no doubt requires some

practice before it can be accomplished with perfect success, and it probably admits of improvement. It has the advantage of great durability; it is applicable to a great variety of objects and materials, while the silver employed is of the utmost purity and beauty.

It may interest our readers to know how this process originated. The author of the present paper had occasion to illustrate in a lecture the readiness with which many salts of silver are decomposed by heat. For this purpose some nitrite of silver was placed on the blade of a penknife and heated over the spirit-lamp; the residue of silver left on the blade was afterwards found to be so firmly attached to the blade that it required to be filed away. This accidental observation led to further experiments, the final result of which was the process we have now described.

Metals are occasionally inlaid with coloured pigments and with enamels. True enamelling on inferior metals, such as bronze, brass, and copper, is not, however, now often practised, and we have to be content with the inferior substitutes for it which oil colours and different kinds of sealing-wax afford, for of such materials consist the so-called enamelled ornament which we often see on the otherwise excellent mediæval brass work so abundantly manufactured at the present day. A hard and purely mineral substitute for these oil paints and coloured preparations of shellac has long been a desideratum. The process now to be described, although far from perfect, is capable of affording some admirable artistic effects. The materials employed have been used for some years by dentists as a white stopping for teeth. Exactly in the same way they may be used as an inlay for almost any material in which grooves, channels, or hollows have been previously cut. This dental preparation goes under the name of "osteo-plastic" and "os-artificiel." It is made of oxide of zinc, worked into a paste with a strong solution of chloride of zinc; these two zinc compounds chemically combine together, heat is given out, and in a few minutes a hard, dense, insoluble white mass is formed, which, when properly prepared, is almost indestructible. The dental os-artificiel generally contains about 10 per cent. of quartz powder, added to increase the hardness of the composition; but, in using the oxychloride of zinc for decorative purposes, this addition is unnecessary, while the admixture of various dry powdered colours, on the other hand, greatly enhances and diversifies the effects producible. The following mineral pigments may be used in the proportion of one part of pigment to nine of oxide of zinc: vermilion, oxide of chromium, cadmium yellow and cobalt blue. The oxide of zinc must be very pure and very

dense.* It is to be made into a stiff paste with water, and then introduced into those hollows of the metal-work which are to be thus decorated. When the paste has become dry the excess is to be removed with a cloth, and then the lines which have been filled up are to be carefully painted over with a strong solution of chloride of zinc. For this purpose a saturated solution, diluted with its own bulk of water, may be used. In ten minutes the composition sets, but it continues to become harder and harder for several days. Where coloured instead of white inlays are required, exactly the same directions are to be followed, the oxide of zinc being, however, carefully mixed with the necessary colours in powder before the composition is moistened with water. In all cases the operation succeeds best when the materials are warm; it is a great improvement to use the chloride of zinc solution hot. Before the oxychloride of zinc sets its surface may be polished with a piece of smooth box wood. For small objects the oxide of zinc may be mixed with the chloride, and the paste at once introduced, but for large objects the paste hardens before the work is finished.

The three processes we have described admit of many variations in practice, variations by which they may be adapted to different forms, designs, and materials.

A RAMBLE IN WEST SHROPSHIRE.

BY THE REV. J. D. LA TOUCHE.

The hilly tract of country which lies to the west of Shropshire has probably been less explored than it deserves. Except to the huntsman, whose earnest pursuit of his favourite sport sometimes carries him into it, or an enterprising geologist resolved to "rough it" at the wayside "publics," which are here few and far between, it has of late years been known to few besides those who actually reside in it. Of late years, I say, for there are abundant evidences that in earlier times it was the scene of a busy and enterprizing population. The mineral wealth with which it abounds having attracted the notice of the Romans, and traces exist of their industry, both in ancient works for the manufacture of lead, and the villas in which they lived. Being, however, considerably out of the highroad of traffic, and separated by the Longmynd, a tract of high land running north and south for upwards of 15 miles, from

* Winsor and Newton's condensed zinc white answers well.

the rest of the country, it is not surprising that its real merits have been so much overlooked. Now, however, that even the solitude of this remote region is penetrated by the railway, and it is thus accessible to the civilized world, it may be not unacceptable to those who, in their summer rambles, prefer diverging from the well-worn track of the ordinary tourist, to be informed of a few of the objects of interest to be found there.

The most interesting feature in this neighbourhood is its geology. It is here possible to trace the history of some of the earliest rocks which form the earth's crust. The traveller by rail from Shrewsbury to Hereford will observe on his right, in proceeding southwards from the former to the latter place, a range of hills, at first low and undulating, but at last becoming a very picturesque and lofty tableland, with steep almost precipitous sides. This is the Longmynd (long mount), and has hitherto been reckoned the earliest water-formed stratum of rock in England; not, however, the earliest known at all, since there is reason to believe that rocks of the same age as these repose on still earlier, the so-called Laurentian, at Sutherland, and there is even a suspicion that a similar fact may be observed in the neighbourhood of Malvern. However, here we see those ancient rocks—the lowest leaves in a book—the aggregate thickness of which, in England alone, is computed, by Professor Ramsay, to be some 14 miles, though even this statement by no means expresses the vastness of the deposits which make up the entire geological volume; there being several breaks in the record—blanks in time, during which, from various reasons, no deposits were made, or those which had existed before were swept away.

This range of hills attains its greatest altitude near the extremely picturesque village of Church Stretton (so called from being a *town* on the ancient Roman *street* which ran through or close to it). A walk from this place westwards, through the deep glens which intersect the hills, shows us at many spots the highly inclined strata of the rock, and it is possible to trace the same up the steep smooth sides of the hills, wherever a course of sandstone, harder than the shale with which it alternates, has resisted the action of the weather, and forms a ridge.

The almost vertical position of these strata, wherever they can be examined for a distance of five or six miles, has enabled Professor Ramsay to compute their thickness at no less than 26,000 feet. The lower beds are much contorted by pressure of a peculiar kind, the layers of strata being puckered in ridges in such a way as to suggest that they have been submitted to an action similar to that which sometimes creases up the

leaves of a book, when, by some accident, pressure is applied to them along their edges, in which case the restraint above and below them, it may easily be understood, would compel them to assume this waved appearance. I have seen a similar, but very much more extensive instance of this curious phenomenon over a great portion of the country between Bray and Wicklow, in Ireland, and, the strata there, being closely allied to these of the Longmynd, it is interesting to find the same physical conditions accompanying them.

But we must hasten through this enormous mass of strata to visit a deposit of much interest which occurs near their top, on the western aspect of the hills; nor will the collection of fossils delay us much in our walk, since they are only remarkable by their absence, so that, except the tracks of worms, and pieces of stone covered with little pits, supposed to be the indentation of rain drops on soft mud, and the ripple marks of primeval tides, there is little which the most ardent collector will care to carry away from this barren tract; and yet these traces of ancient atmospheric action, and even these worm-tracks cannot but furnish to any thinking mind abundance of food for meditation. We here see proof that this vast deposit was formed under the conditions of a constantly sinking shore, whose surface was left dry after each tide swept over it—here, as to-day, the sun shone, and caused these cracks, the wind blew, and so these ripple marks were formed; then, as now, over those dreary wastes the showers of heaven fell, and a worm similar in its mode of progression to that which is to this day found on our coasts, crawled along its surface. How much could we desire to know whether other animals of a higher organization existed at the same time? Where, too, were the vast tracts of continent which supplied the materials for these rocks? Such questions as these will probably remain very long unanswered. It is to be remembered that in geological strata we have only the records of those conditions which exist under water, and that, in but very rare instances, is there any reason to expect the preservation of specimens of land growth.

The next deposit to which I would direct attention is the conglomerate, which is found along the western slopes of the Longmynd, and which seems to have had, at least in this locality, a very extensive range, as it is also found near Shrewsbury, at Sharpstone Hill, and elsewhere. This deposit furnishes us with some specimens, at least, of still more ancient rocks, water-worn and glued together in a vast mass. The study of these conglomerates, where they occur, is very interesting, since they disclose not only the nature of some of the pre-existing rocks, but even may indicate, to some

extent, the configuration of the land where they were deposited. Similar deposits are occurring at the present day, and give us a clue to the conditions under which these early ones were formed. Reasoning thus, we may conclude, when we find a conglomerate, that we are in the immediate neighbourhood of some ancient sea beach or estuary, or that this was the site of some vast river or mighty current; stones such as those which are found in it, are never carried out to any great distance from the land. In this conglomerate, moreover, may be remarked a very striking instance of that slow but immensely powerful process by which change takes place in the very substance of the materials of which the earth's surface is composed. It is in several places traversed by veins of quartz running right across the strata in direct lines, so as to traverse even the substance of the pebbles which lie in their way. It is easy to conceive a crack occurring in a solid rock, and to suppose quartz infiltrated therein, but such a supposition cannot be admitted here, there is no appearance whatever of any fissure by which these pebbles could have been divided, and yet, where they lie in the course of the line of quartz formation, a portion of their substance has become quartz. It is clear that here we perceive evidences of a kind of chemical action taking place in a certain plane, and suggests to us that, on a larger scale, the same may account for many of those effects which have been too frequently ascribed to igneous and volcanic action, in default of any known cause, just as it is the custom, among those who are quite ignorant of the laws of electricity, to attribute to it every unaccountable phenomenon.

But it is time for us to wend our way westwards to the Stiperstone range—hills of considerable height running parallel with the Longmynd. This ridge is considered, by Sir R. Murchison, to be the representative of the Lingula flags of North Wales, and the lowest member of the Silurian group. Its most marked physical feature is the existence at intervals along its summit, for a distance of ten miles, of huge masses of rock protruding from the surface to the height of twenty or thirty feet. These rocks, being quartzose, and very much harder than the surrounding strata, have resisted more effectually the action of the atmosphere, to which the whole has been exposed since its emersion from the ocean, and there they stand like gigantic fortresses, grey and ribbed with age, looking down in lonely majesty on the silent, ceaseless decay of all around; adding, too, their own contributions to the general ruin, as is testified by the masses of rock torn from their sides by many a frost, and which lie beneath them on the flanks of the hill.

Sir R. Murchison has observed that there are several

bosses of greenstone in the neighbourhood of the Stiperstones, which indicate the existence in past times of great volcanic heat, and there can be little doubt that, under the influence of this, the origin of almost every physical result, a metamorphic action took place in the already deposited rocks, and, by that segregative force to which I have already alluded, some portions assumed properties distinct from the strata in close connection with them.

We now are, at last, in the region of fossils. Near the top of the Stiperstone ridge, and on the western flank, in the holes scratched by the sheep to form for themselves a little shelter in the bleak winter days, may be found fragments of trilobites and shells of very early types. Not sufficiently explored, indeed, are these deposits; but the task of doing so is difficult, both from the remoteness of their locality and the few spots at which any access can be obtained to them.

From the lofty ridge on which we now suppose the geologist to stand, he looks westward on an extensive undulating country, chiefly consisting of what is called the Llandeilo formation, and towards the south-west he sees, standing up prominently out of the lower lands around it, the hill of Corndon, a mass of greenstone or volcanic rock, representing a vast upheaval of strata in its neighbourhood, and causing a kind of V shaped arrangement of the intermediate beds, they having been raised up both along the line of the Stiperstones, on the one hand, and by the protrusion of the Corndon, on the other.

And here, for the present, we must leave our tourist contemplating a scene which has, whenever I have had the opportunity of surveying it, filled me with admiration. The wild hillsides of the Stiperstone range, covered with bog and heath, contrast well with the fertile country below; the gaunt mass of the Devil's Chair and other rocks, which at intervals rear their forms boldly out of the crest of the ridge; Corndon in the distance, once perhaps, a glowing mass; and, according to Sir R. Murchison, volcanoes in full activity once reared their peaks above the waters which covered the earth when these enormous strata were being deposited. The evidences of such mighty operations of nature, the cinders of the vast forge in which the earth's crust has been moulded, may well impress us with a sense of the powers which are in ceaseless action round us, and which have from all eternity, and will to all eternity, evolve the purposes of the Creator.

RUMINATION IN FISH; THE SCARUS OF THE ANCIENTS.

BY REV. W. HOUGHTON, M.A., F.L.S.

Rumination, or the power possessed by certain animals of casting up small portions of food from the stomach into the mouth for the purpose of re-mastication, is amongst mammalia normally confined to the ruminant order, comprising the families *Camelidæ, Moschidæ, Camelopardidæ*, and *Bovidæ*, including the antelopes, sheep, and cattle. I say *normally*, because, as is well known, certain individuals of the genus *homo* have been known to possess this power.* Moreover, Professor Owen has, I believe, observed a quasi-ruminant power in some species of kangaroos. It is possible that careful observation may discover occasional instances of abnormal rumination in other orders; in most of the mammalia there is nothing to prevent the regurgitation of food from the stomach into the mouth for re-mastication, but in some there is a mechanical obstruction, as for instance in the horse, the valvular construction of the entry of whose stomach renders such an act impossible. It appears, however, from the investigations of Professor Owen, that rumination is not confined to the mammalia alone. Certain families of the class *Pisces* possess a power essentially identical with rumination.

"The muscular action of a fish's stomach," says our great anatomist, "consists of vermicular contractions, creeping slowly in continuous succession from the cardia to the pylorus, and impressing a twofold gyratory motion on the contents; so that, while some portions are proceeding to the pylorus, other portions are returning towards the cardia. More direct constrictive and dilative movements occur, with intervals of repose, at both the orifices, the vital contraction being antagonized by pressure from within. The pylorus has the power, very evidently, of controlling that pressure, and only portions of completely comminuted and digested food (chyme) are permitted to pass into the intestine. The cardiac orifice appears to have less control over the contents of the stomach; coarser portions of the food from time to time return into the œsophagus, and are brought again within the sphere of the pharyngeal jaws, and subjected to their masticatory and comminuting operations. The fishes which afford the best evidence of this ruminating action

* A friend of mine when studying in Germany told me of a case of rumination in the school he attended. One of the boys possessed this very undesirable accomplishment, and in consequence of his persisting in the habit in spite of all remonstrances, he was obliged to leave the school.

are the Cyprinoids (carp, tench, bream), caught after they have fed voraciously on ground-bait previously laid in their feeding-haunts to insure the angler good sport."

It is curious to observe that Aristotle, many hundred years ago, recorded the existence of a ruminating fish. "The fish known by the name of scarus," he says, "is the only one which appears to ruminate like quadrupeds." What the scarus probably denotes I shall consider by and by. The idea of a ruminating fish appeared to the commentators so absurd that they put down the statement of Aristotle as a simple myth; and even Mr. G. H. Lewes, in one of his instructive works,* citing this amongst Aristotle's "examples of careless observation and rash generalization," utterly discredits the possession of ruminating properties in a fish. He says, "If true, the fact must be one difficult of observation, since fish will not exhibit their ruminating propensities out of the water, and *in* the water it could hardly have been watched. Is it true?" In a foot note, Mr. Lewes adds, "Milne Edwards states it without misgiving in his *Leçons sur la Physiologie et l'Anat, comparée*, 1861, vi. 290, referring to Owen's *Lectures on the Vertebrata* as his authority. In a private note, Professor Owen informs me that the *Scarus* named by Aristotle has not been identified, but that 'the carp, by a rotatory motion of the gullet, brings the vegetable food-contents of the stomach successively within the sphere of the action of the strong pharyngeal grinding teeth, whence the pulp is returned to the stomach fitted for passing the pylorus'" (pp. 282, 283). Now we naturally wish to ascertain how Professor Owen has convinced himself of this fact, which at first sight appears difficult of verification. The professor tells us, "A carp in this predicament [after having fed voraciously on ground-bait] laid open, shows well and long the peristaltic movements of the alimentary canal; and the successive regurgitations of the gastric contents produce actions of the pharyngeal jaws as the half-bruised grains came into contact with them, and excite the singular tumefaction and subsidence of the irritable palate, as portions of the regurgitated food are pressed upon it. The shortness and width of the œsophagus, the masticatory mechanism at its commencement, and its direct terminal continuation with the cardiac portion of the stomach, relate to the combination of an act analogous to rumination, with the ordinary processes of digestion, in all fishes possessing these concatenated and peculiar structures."†

In a communication with which he has kindly favoured

* *Aristotle, a Chapter from the History of Science.* London: Smith, Elder, and Co. 1864.

† *The Anatomy of Vertebrates*, vol. i. p. 419.

me, Professor Owen makes the following further interesting remarks, "Continued observations, under the rare and difficult circumstances according to which they can be made, have now convinced me that matters for mastication by throat-chewers come *from behind*, as those by mouth-chewers *from before*. And indeed when one came to consider how thoroughly and regularly the mouth of a fish is washed out by the branchial streams, there needs must be some special arrangement for the masticating machinery in lithophagous and phytophagous fishes. Consider what would be the consequence to the partially broken up coral and pulp if retained at the back of the mouth to be pounded piecemeal by the pharyngeals, the rush of two diverging streams through that faucial area going on the while like clockwork. No! the food reduced if needful to a size swallowable, is bolted, and the branchial way speedily cleared. Then comes into play that anti-peristaltic rotation of the short gullet, and bit by bit the contents are shed in *a tergo* between the grinders till all is pulped." I have lately had an opportunity of examining a carp, but the whole intestinal tract was perfectly empty. This is probably the case with the *Cyprinidæ* generally during the cold months. We must wait for warm summer weather when we may be rewarded by witnessing what Professor Owen has so minutely described, There are good figures of the throat-teeth of the carp, tench, roach, and barbel, in Yarrell's *British Fishes*. (Introd. p. xx.) The worn appearance of the crowns of these teeth in the carp are very striking, being, as Yarrell says, like "the molar teeth in the hare." Besides the pair of pharyngeal jaws, there is, in the carp and tench, a single occipital tooth, situated between the pharyngeal pair, and upon which, as upon an anvil, these last-named teeth appear to work.

With regard to the fish known to the ancients by the name of *Scarus*, although positive specific identification is certainly not warranted by the accounts given of it, yet there is some evidence in favour of its being a species of scarus still found in the localities assigned to it in the writings of the ancients. According to Aristotle, the scarus is remarkable for the form of its teeth; it differs from all other fish in not having pointed or shark-like teeth (*καρχαρόδοντες*), though Aristotle does not tell us what sort of teeth it had. Its food consists of sea-weed. He alludes to its ruminating propensities in two places; and the story descends, being narrated by Œlian, Athenæus, Ovid, Pliny, and others. According to Horapollo (ii. 109), the ancient Egyptians delineated a scarus when they wished to symbolize a man given to gluttony, "for this fish is the only fish which ruminates and eats all the little fishes which fall in its way." Oppian speaks of the scarus frequenting rocks

covered with sea-weed, and assigns to it the possession of a voice :—

> "Here scaros feed, the only kinds that dare
> To form shrill sounds, and strike the trembling air.
> To pensive silence doom'd, no other fish
> Can speak his wants, or tell his secret wish;
> Thrice o'er their food the wanton scaros eat,
> With pleasure the luxurious toil repeat,
> Like sheep in grassy meads, or fat'ning kine,
> They chew the cud, and on the taste refine."*

Amongst other of the varied accomplishments attributed to the scarus may be mentioned the mode by which it would rescue one of its captive friends, as it lay confined in the weel trap. The scarus would insert its tail between the twigs, and the prisoner would seize it with its teeth, and so be dragged out by main force, the captive firmly holding in his mouth the liberator's caudal appendage! From Horace and Martial we learn that the scarus was a favourite and dainty dish; the latter speaks of its being only good when cooked with its intestines :—

> "Hic scarus, æquoreis qui venit obesus abundis,
> Visceribus bonus est ; cætera vile sapit" (xiii., 84).

Similarly Athenæus (*Deipnosoph*, vii., 113), quoting Epicharmus—

> "We fish for spari, and for scari too,
> Whose very dung may not be thrown away."

Archestratus, in his recommendations as to the best mode of cooking scari, refers to the form of the fish in the following line :—

> *καὶ μέγεθος κυκλίᾳ ἴσον ἀσπίδι νῶτα φοροῦντα.*
>
> "With back as broad as a large round shield,"

a description quite applicable to some of the scari.

Pliny says of this fish :—"At the present day, the first place is givin to the Scarus, the only fish said to ruminate and to feed on grass, and not on other fish. It is mostly found in the Carpathian Sea, and never of its own accord passes Lectum, a promontory of Troas. Optatus Elipertius, the commander of the fleet under the Emperor Claudius, had this fish brought from that locality, and dispersed in various places of the coast between Ostia and the districts of Campania. During five years the greatest care was taken that those which were caught

* *Halieutics* I., 215—222. Draper's translation. Oppian's own words are very clear and expressive :—

> *κὰι μοῦνος ἐδητὺν*
> *ἄψορρον προίησιν ἀνὰ στόμα, δεύτερον αὖτις*
> *δαινύμενος, μήλοισιν ἀναπτύσσων ἴσα φορβήν.*

should be returned to the sea, but since then they have been always found in great abundance off the shores of Italy, where formerly there were none to be taken" (ix., 30). The scarus was of various hues (ποικίλον). Nicander says there are two kinds of scari—one was called ὀνίας, the other αἰόλος, "with changeful hues."* Now it happens that a species of scarus of modern ichthyologists is still found in the Carpathian and Ægean Seas; it was noticed by Spratt and Forbes, who thus speak of it:—"Another fish frequently mentioned by ancient writers is the scarus; it was supposed to ruminate its food, a fancy to which the peculiar aspect of its teeth may have given rise. This was, doubtless, the *Scarus cretius* of modern ichthyologists, a fish abundant on the Lycian shores, and still called by its ancient name. It is remarkable for the variations of colour it presents at different seasons; at one time being of the most livid crimson, at another of a dull bluish-grey, and sometimes piebald of the two colours" (*Travels in Lycia*, ii., 86).

Aldrovandus identifies the ancient scarus with a fish he calls *Scarus cretensis*, and Cuvier says, "The Archipelago contains one species, of a blue or red colour according to the season, which is the *Scarus creticus* of Aldrovandus, and which, after new investigations, I believe is the true scarus so celebrated among the ancients. It is still eaten in Greece, and its intestines are used for seasoning" (*Animal Kingdom*, p. 311, edition Carpenter and Westwood). Now the structure of the jaws in the genus *Scarus*, which has given the name of "parrot-fish" to the different species comprised in it, is very remarkable; and if the ancient scarus is identical with the scarus of modern naturalists, it is strange that, amongst the numerous notices of the scarus in classical authors, there is nothing like a description of its teeth, nor, indeed, is there any clue at all that would be sufficient to enable us to speak with certainty about its identification. The sharp, parrot-faced mouth of the modern scarus is used by the fish for the purpose of biting off the stony corallines, nullepores, etc., which form the chief proportion of its food.† As Professor Owen has said, its mouth "is peculiarly adapted to the habits and exi-

* ὀνιας is derived from ὄνος "an ass," and is applied to the scarus on account of its grey colour. There is little doubt that both αἰόλος and ὀνίας denote the same fish according to its colour at different seasons, ὀνίας being well represented by the "dull bluish-grey" of Spratt and Forbes.

† The teeth of the scarus are figured in Professor Owen's *Anatomy of Vertebrates*, vol. i.; also in the *Odontography* of the same author, and in the *Cyclopedia of Anatomy and Physiology* by Todd and Bowman (Art. Teeth). Professor Owen draws attention to the close analogy between the dental mass of the scarus, and the complicated grinders of the elephant, both in form, structure, and in the reproduction of the component denticles in horizontal succession. *Anatomy of Vertebrates*, vol. i., p. 381.

gencies of a tribe of fishes which browse upon the lithophytes that clothe, as with a richly-tinted carpet, the bottom of the sea, just as the ruminant quadrupeds crop the herbage of the dry land." In another place he says, "the proof of the efficacy of the complex masticatory apparatus is afforded by the contents of the alimentary canal of the scari. The intestines are usually laden with a chalky pulp, to which the coral dwellings have been reduced." Now corallines, in the time of Aristotle, were regarded as sea plants, and might well enough be intended by Aristotle's *φυκίον*. But what led the Stagirite to believe that the scarus ruminated, when he denies the power to all other fish, although certain species of *Cyprinidæ* were known to him? Was he acquainted with the pharyngeal teeth of the scarus? Probably he was only repeating, as he often did, a hearsay story; and the peculiar beak-like jaws of the scarus may have suggested to some Greek fisherman the idea that it ruminated. It is probable that the scarus, like the *Cyprinidæ*, returns portions of the hard coralline contents of its stomach for trituration by the masticatory pharyngeal teeth; but the ancient idea, if a fact, was not the result of a scientific investigation or observation, but simply a happy guess.

LUNAR DELINEATION.—THE LUNAR ARISTILLUS AND AUTOLYCUS.

BY THE REV. T. W. WEBB, M.A., F.R.A.S.

Some remarks were made, in our last number, on the expediency of forming a monograph of the lunar spot *Cassini*, by means of a series of sketches taken under very varied angles of illumination. Nothing less than this is in fact demanded for every accessible part of the visible hemisphere of our satellite, before our knowledge of her surface can be considered commensurate with the progress of modern astronomy. We have here evidently an undertaking involving the employment of many eyes and hands, and extending, especially in our turbid climate, over many seasons; and as it lies somewhat on one side of the province of the regular observatory, so fortunately it is one in which amateurs may render very efficient aid. This indeed is being done to some extent at the present moment; but a considerable increase may be looked for in the number of such observers, both from the attention which the subject has attracted of late years, and from the far greater

ease with which adequate optical aid is now attainable. All of these cannot be expected to bring to their task a full knowledge of the peculiarities of lunar delineation, a subject which in fact has been hitherto little explained; and to those less skilled in such matters the following remarks may be of use.

The time in lunar drawing is long gone by when "anything would do," or when pictorial effect could be substituted for painstaking accuracy. What is now wanted is nothing less than fidelity in outline, and fulness in detail. For this purpose, some artistic training is highly desirable. It is to be regretted that a fair portion of skill in design is not required of every person pretending to a liberal education; the advantages and the gratification arising from it would be found matters of almost daily experience, and to the possessors of telescopes it would be of especial value. Any one who has been accustomed to sketch frequently from nature, and who knows how wonderfully varying are the effects of light and shade on the same object at different times of the day and seasons of the year, and from even slightly varied points of view, and how details, which under some circumstances are not only perceptible but prominent, vanish under an altered relief of the surface, will find little difficulty in making or interpreting drawings of our satellite.

To others all this is less easy, but let them persevere; they will (or ought to) master the subject in the end, and with much interest by the way. Success, however, can scarcely be expected, unless due precautions are attended to, and the ordinary rules of drawing observed. Students should be content with advancing from simpler to more complex forms, and, instead of filling in outlines with a number of unmeaning scratches and careless shadows, endeavour first to master thoroughly the nature of what they see, and then to give to every stroke and shading its due significance in representing it. Such drawings alone can be really satisfactory to the designer, or worthy of preservation.

It is of consequence that too large an area (however full of interest) should not be attempted at once. Much time would be wasted in getting correctness of general position, which, after all, would be best left to the micrometric or photographic observer; and those details which in the present state of selenography are far more valuable, would be hurried over, if not in part omitted. And besides this, even if a long night during the high reign of a winter's moon were selected for a large design, the shadows near the terminator would be found, in the course of a few hours, to have materially altered in length. It is better on every account to content ourselves with well-worked studies of circumscribed areas. Many such might be

satisfactorily obtained in the time wasted in some extensive and disappointing attempt.

Having chosen a region suitable for our purpose, we ought obviously to sketch it under many varying angles of incident light—soon after the lunar sunrise, more than once during the advancing morning, at midday, and several times as the afternoon declines, and towards sunset. This, however, partly from weather, partly from the fact that the moon is not always in an observable position at the required epoch, could not be accomplished in a single lunation. Our whole series of studies of any one spot must inevitably be made up of sketches taken during different monthly periods, and perhaps after considerable intervals; and we must be prepared for discrepancies arising from this cause. We may notice a slight difference in the direction of the illumination, and, excepting near the centre of the disc, the perspective foreshortening and relative bearing, or what may be termed *allineation,* may be somewhat altered; and this may be accompanied with a change in the visibility of minute details. Hence we shall feel inclined to multiply our sketches, and to institute comparisons between such as bear a general resemblance; and thus we shall materially enlarge our knowledge of the true nature of the surface. In order, however, to avoid mistake, the following considerations must be borne in mind.

Whatever similarity may exist at first sight, no strict comparison can take place between any two sketches in which the angles of illumination and vision are materially unlike. If, indeed, the representations taken under such different circumstances should be found to agree, one great point is gained: we ascertain not only that the features are the same, but that they are not of a character to vary much in appearance from such causes. If, on the other hand, there should be much discordance, we are still a long way from any safe inference as to physical change. For while the angles of incident light may be indefinitely varied, and frequently with little apparent effect on the aspect of objects, there are cases in which a very slight difference in the sun's altitude or azimuth would replace brightness by a half tone, or even a black shadow; and so again a varied angle of vision, even if it does not, as may often happen, affect the brightness of the surface more directly, may influence our view of it materially by exposing or concealing portions in light or shade. Either of these causes therefore, or both conjointly, may account for much apparent incongruity of representation. If the moon revolved around us in a circular orbit, in the plane of the ecliptic, and with an axis perpendicular to that plane, neither of these sources of discrepancy would exist, but every portion of the surface would be illumi-

nated and viewed under precisely the same angle at the corresponding hour in every successive lunation; and in that case any apparent would certainly indicate a corresponding physical alteration. But since none of these three conditions of identity are fulfilled, variations of aspect, especially among the minuter details, are of continual occurrence. And while these doubtless enable us to become better acquainted with the character of some objects, as a countenance is better understood under slight differences of position, than when gazed at in the unvaried fixity of a portrait, still all such accidental causes of variation have to be allowed for, and, as far as possible, eliminated, before we can pronounce upon the probability of physical change.

In order then to be able to compare with rigorous accuracy any two drawings of the same lunar object, presenting general similarity with difference in detail, it would be necessary to ascertain by calculation the altitude and azimuth both of the sun and of the eye of the observer, as viewed from the spot in question, at the epoch of observation, and this would involve a number of troublesome computations. But, fortunately, for general purposes the end may be sufficiently attained, in most cases, in a much simpler way. First, we have to consider the conditions of illumination, as to vertical angle and lateral direction. The vertical angle depends upon the distance from the terminator, that distance being equal to the altitude of the sun at the place. It will be sufficient therefore for our purpose if we record the position of the terminator as regards some conspicuous feature near the observed region, specifying for instance that it bisects the ring of a known crater, or that one-third, or three-quarters of the ring are enlightened, or that its summit is just touched by the sun in the night-side, or that it has advanced by its own diameter, or so many parts of its own diameter, within the boundary line. This degree of accuracy will in general be quite sufficient to ascertain the vertical angle of illumination, or elevation of the sun above the horizon of the feature we are observing. But the lateral direction of the illumination has also to be attended to; in other words, the azimuth, as well as altitude of the sun, as viewed from the lunar spot. For though it is the difference of seasons upon the earth that causes the sun to have such widely different bearings by compass at equal altitudes at different times of our year; and though, in a popular sense, it may be said that the moon has no seasons, yet this is not strictly true. It would be so if she revolved in the plane of the ecliptic, on an axis at right angles to that plane, for then the sun would rise and set on the same point of the lunar compass throughout the lunar year. But her axis is not perpendicular to her orbit (nor

to the ecliptic), being inclined to it at an angle of 1° 28′ 47″.* Hence results a continuous and systematic change, analogous to that of the terrestrial seasons, only as inferior in extent as the angle 1° 28′ 47″ is to 23° 27½′ (the inclination of the earth's axis). And consequently each pole of the moon is in light or darkness by turns; and the horns are constantly approaching, coinciding with, or departing from, the polar points; and the "line of the horns," that is, the chord of the whole terminator, or the terminator itself when it is a straight line, seldom coincides with a lunar meridian, but intersects it at the equator in some small and constantly varying angle. The result of these changes is that, instead of rising always due E., the sun, as viewed from the moon, may sometimes rise about 1½°, or three times its own apparent breadth, N., sometimes as far S. of that point; and as, under such circumstances, a house standing due E. and W. on the earth would see the sunrise sometimes from its N., at others from its S. windows, so a line of cliffs running due E. and W. on the moon would sometimes be bright in the early morning, sometimes all in black shadow. To eliminate such apparent discrepancies, we must obtain not merely, as already specified, the distance from the terminator, that is, the sun's altitude, but also the direction of the terminator itself, which is equivalent to his azimuth. And as the former *datum* is obtained by the position of the terminator as regards some known spot as near as may be to the region we are studying, so we get the latter by noting its position in the same way with regard to two other spots, lying as far N. and S. as we can conveniently find them, from the more central one already referred to. The *distance* and *direction* of the terminator being thus ascertained, we can compare the angles of illumination at different epochs with sufficient accuracy for our present purpose.

The varying direction of vision depends upon other considerations, and two other distinct data are required—libration in longitude, and libration in latitude. The effect of the former at its maximum would be the same as if the eye of the observer were shifted to points alternately 7° 55′ E. or W. of its normal position; the latter at its maximum would in like manner transpose it alternately 6° 47′ N. or S. These two changes, involving, at least, the *possibility* of much diversity of aspect, are combined in every proportion and degree; but fortunately for amateur selenographers, their adequate expres-

* The inclination of the moon's orbit, and its continually varying direction from the motion of the nodes, have not been noticed here, because, though very conspicuous to us, they subtend so extremely small an angle, not exceeding 50″, when viewed from the distance of the sun, as to exercise no perceptible influence on the direction of the incident light.

sion is very simple and attainable. Libration in longitude may be represented by the interval of time since, or until, the nearest perigee or apogee (or both may be specified if each is distant): if these intervals do not greatly differ in the drawings to be compared, the change in the direction of aspect E. or W. can have no material effect. Libration in latitude is correlative with the latitude of the moon at the epoch of observation; and if this nearly corresponds, so does the position of the observer's eye as regards N. and S. We have only therefore to take from the *Nautical*, or *Dietrichsen's Almanac*, the date of the nearest perigee or apogee, or both, and the value of the latitude (which however ought to be *reduced* by a little calculation *to the hour of observation*), and we have all the materials for judging whether the circumstances of vision are sufficiently similar to admit of close comparison. And it will now be apparent, that if the *distance* and *direction* of the terminator, and the amount of *each* libration, are not materially different at two different epochs, then, and then only, will the corresponding drawings admit of such a rigorous comparison as not only to establish general coincidence, but to check those minute details to which astronomers are now beginning to attend.

It should, however, be borne in mind, that though the form, or position, or reflective quality of certain objects may render them, so to speak, peculiarly sensitive to slight changes in the angles of illumination and reflection (which is of course only that of vision reversed), yet in the majority of cases but little variation ensues, and that of a readily intelligible nature: and it is fortunate for selenography that it is so, since otherwise it would present a scene of such continual unsettledness as to detail as to be the source of endless perplexity and uncertainty; especially when we consider that an exact state of mean or balanced libration returns only once in three years. Schröter pointed out long ago that the ordinary changes of aspect thus arising lie within narrow bounds; and experience will soon convince us that, though we ought to be on our guard, and more than he may have sometimes been, against special cases of apparent change, yet the general aspect of things is not subject to any extensive variation, beyond that gradual transformation from light and shade to local colouring which attends the progress of the sun to the lunar meridian. As to the special cases just referred to, many such exist; some already known to astronomers, to which we shall call attention as they come before us; many more remaining yet to be studied with care, not only to acquire a minuter knowledge of the lunar surface, but to be able to pronounce more decidedly as to the truth or groundlessness of Schröter's idea, that many seeming variations indicate the

existence of an atmosphere whose denser portion does not extend much above the lower regions.

THE LUNAR ARISTILLUS AND AUTOLYCUS.

At a short distance S.W. from our last object, *Cassini,* and near the foot of the *Caucasus,* with which, however, it has no apparent connection, we shall find a smaller, but very obvious crater, *Theætetus,* so deep, that it is wholly free from shadow for about five days only during the whole lunation. The W. wall rises 7600f. above the interior, and higher still in one bright peak: the E. side is 3500f. above the plain; Schr. had given 3300f.—a close agreement. The latter made the depth 10,000f. From the data of B. and M., Schmidt found the ratio of the outer and inner heights of the wall as 1 to 2·6, and the depth $\frac{1}{13}$ of the diameter, this latter being a not unusual proportion in craters of between 12,000f. and 19,000f. in breadth. The character, therefore, of extreme relative depth—the goblet-like impression—which might be easily received in such cases from the appearance of the shadow near the terminator, is thus shown to be somewhat deceptive when checked by actual measurement. But though our lunar cups may thus be said to be turned into saucers, enough remains in their proportions to fill us with astonishment.

A double ridge rising only some 100f., and throwing off four parallel branches to the S.W., leads from *Theætetus* towards *Aristillus* (21), a crater from its size, depth, and position, belonging to the most striking class. The mass of wall, enormous in itself, but still more impressive as the result of eruptive action, though less lofty N. and S., rises W. nearly to 8900f., and with a steeper peak to fully 11,000f., the height of the great Pyrenean Maladetta (the latter measured, however, from the sea, and producing, therefore, a less imposing effect). Schr. gives the E. side 6750f. above the surrounding *Palus,* the depth 9400f. A formation here lies beneath our eye, to which nothing terrestrial makes more than a very distant approach. What would be our feelings if transported to the midst of this huge cavity, and gazing upon its colossal boundary at a distance of seventeen miles on every side! The central hill on which we should have to take our stand is a commanding one, and of a complex character, which has not been well exhibited in the published designs. It really consists, as I found, 1861, Dec. 10, with $5\frac{1}{2}$ inches of aperture, and power 170, of three parallel ridges separated by narrow ravines, rising towards S.W., and terminated, especially the outer ones, by bluffs at that end. The S.E. ridge, which is the longest, is

also enlarged at the opposite extremity; and as they progressively and rapidly decrease in length, the whole mass approaches to a triangular form. The most remarkable feature, however, connected with *Aristillus*, is the system of radiating ridges, which extend in all directions, especially S., for a distance of ten, twenty, or even thirty miles from the foot of the ring. These were discovered by Schr. in 1796, who describes them as an "innumerable multitude of little, very flat, low hills, for the most part connected and forming longish ridges, which have collectively received their general direction from the centre of the crater." This remarkable arrangement is not a difficult object, but must of course be looked for under a low illumination. I have seen it extremely well when the terminator has bisected the ring of *Archimedes* (33) a little way S.E. It is deserving of especial examination by those possessed of superior instruments, as in no part of the moon, perhaps, can this peculiar branch of the evidence of explosive action be studied to more advantage. Similar systems exist in other quarters; we shall recall the grand one of *Aristoteles;* we shall hereafter meet with others on a large scale; and I believe that careful search would detect them in places where they have not as yet been clearly described. But in the case before us, the distinctness and comparative simplicity of the radiation, as well as its favourable position with regard to our eyes, mark it out as a leading instance peculiarly adapted for the prosecution of the interesting inquiry, What was the nature of the force by which these cavities were produced, and through what processes did they receive their present form? The time is now coming when such investigations may be carried on upon more reasonable grounds. M. Chacornac has already distinguished himself by his original and ingenious speculations, and as observations are multiplied, selenological theories will be proposed, discussed, and some of them, no doubt, abandoned in their turn. On the present occasion, I venture to submit the following entry from my observing-book: the date being 1863, Dec. 17, the terminator being in progress from bisection to inclusion of the ring of *Aristillus;* instrument, my $5\frac{1}{2}$ in. achromatic, power 170; air unsteady; definition "imperfect and uncomfortable."

"The lava streams finely seen; they are confined to the lower part of the glacis, as in *Aristarchus*. The wall proper is a narrow ridge, showing no sign whatever of having been overflowed or broken down, but clearly of a horizontal character like a terrace; beneath its foot on the S.W. are two sharp, steep, narrow terraces; W. and N.W. there are irregular and rounded mounds; but in each case the source of the lava lies beneath, as though it had squeezed its way through beneath

(in which case the wall would scarcely have been so continuous and regular), or more probably had flowed previously, the upper regions being elevated in a cooler and less fluid condition."

Upon so imperfect a ground no theory ought to be, or is attempted to be, put forward. The extract is given merely as a specimen of the ideas which might naturally occur to any observer, as they did to myself, on examining this instructive formation as the sun was rising upon it. They may be very unfounded: possibly a further exploration might lead me to reject them for fresh notions, in the opinion of other observers equally baseless. But it is by a tentative process of this kind that we are most likely to approach the outskirts of that truth which the great Creator has perhaps willed to be in its fulness an impenetrable mystery. This we may plainly see, that such a radial arrangement must have been determined, like the circular form of the crater, by a central force: but in what manner, it is less easy to conjecture. The divergent matter might have been extruded in a semi-fluid condition analogous to lava; a condition again which might have originated either in igneous or aqueous action. It might have been poured out before the final formation of the ring, or have pierced the flanks of the mountain, as frequently happens in terrestrial eruptions, or have flowed over the ridge subsequently without leaving any trace perceptible to our vision, from the already hardened condition of the wall, and its standing up so steeply as to cast off the viscid matter to the more gradual slopes below. These radiations may be streams of enormous blocks in a non-coherent state, like beds of cinders on the flanks of a terrestrial volcano; and such torrents might have had their source either in the downpour of ejected fountains of stones, or in the overflow of a great mass of similar matter collected within the crater, and making its escape chiefly through gaps in its highest ledge. Such speculations may be, some of them, very improbable, but perhaps are none of them to be rejected for their dynamical impossibility. Each of them, therefore, might be compared with the observed appearances; and from rough hints of this kind, well applied here, and extended to other formations in distant quarters, some inference might, perhaps, result which might be worthy of serious consideration.

Aristillus is also the centre of a system of those mysterious light-streaks so familiar to every observer, and so difficult of explanation. Many of these diverge on the W., N.W., and N. sides; on the E. they extend to some distance through the *M. Imbrium*. It is well worthy of notice, that, except in a few instances, they do not coincide with the

rows of hills; and on the S., where the ridges are boldest, and fill all the space as far as *Autolycus*, they are entirely wanting. This entire independence of hill-radiation and light-divergence is a singular, but general characteristic of the moon.

A short distance S. of *Aristillus*, we find another grand crater, *Autolycus* (22), similar, but somewhat inferior to its neighbour in almost every respect. Its breadth is twenty-three miles; its depth beneath the E. wall 9000f., the height of the W. wall 8400f. above the cavity, 4800f. above the exterior base. The latter measures are given at 8800f. and 6000f. by Schr., who observes that the great Canigou, the chief of the E. Pyrenees, would stand in its interior. The larger ratio of its depth, and the small dimensions of its central hill show some modification of eruptive force as compared with *Aristillus*, but it is surrounded in the same way, though not to so great an extent, by radiating streams of blocks or lava. Where these two systems approach and mingle with each other in the space between the craters, might it not be possible for some of the most powerful telescopes of the day to detect evidence of unequal date? The light streaks which Schmidt ascribes to *Autolycus*, though in a less degree than to its neighbour, were neither drawn nor described by his predecessors, and this is so far worthy of notice, that the permanency of these uncomprehended markings has hitherto been assumed rather than proved. The streaks of *Aristillus*, he says, are best viewed in the wane. Schr. has remarked that the interiors of these two craters, like those of *Cleomedes*, *Endymion*, *Schickhard*, and others, grow darker under a higher angle of illumination. I have seen in the decreasing moon, when the terminator lay a little less than its own diameter beyond *Posidonius*, a remarkable ledge on the interior slope of the wall of *Autolycus*, marked through more than a quadrant by a separate shadow.

A singular remark of B. and M. in this place must not be omitted, to the effect, that such combinations of two (or even more) craters are frequently met with, lying under the same meridian, in which the steepness and formation of the wall within and without, the relative height and reflectiveness, in short, the whole character, are nearly the same, and both are equally conspicuous. If they differ in size, the smaller lies S., and in that case their diameters are in the ratio of three to four; they are about 18 to 36 miles apart; and connected by several more or less marked ridges running from the N. to the S. crater in a S.W. direction. Examples, Aristillus and Autolycus; Petavius and Furnerius; Agrippa and Godin; Aristoteles and Eudoxus; Ptolemæus, Alphonsus and Arzachel;

Schickhard and Phocylides; Scheiner and Blancanus, Moretus and Short; Geminus and Burckhardt.

OCCULTATIONS.—April 8th. ALDEBARAN, 2h. 9m. to 3h. 9m.—9th. 130 Tauri, 6 mag. 7h. 33m. to 9h. 40m. The former will be interesting, as taking place in broad day; but it will probably require an equatorial mounting to find the moon, being then a crescent of less than four days old.

ON A FRESH WATER VALVED VAGINICOLA.

BY HENRY J. SLACK, F.G.S., HON. SEC. R.M.S.

IN Pritchard's *Infusoria* (4th edition) is an account of a valved Vaginicola, described by Dr. Wright, and sketches of the creature are given in Plate xxviii., Figs. 18 and 19. It is described as "distinguished from *V. crystallina* by the remarkable valve existing in its case or sheath—which closes in an inclined position over the animal, when it retreats to the bottom of its case; by the body being colourless, without the green globules seen in *V. crystallina*, and by being an inhabitant of salt water instead of fresh." No size is given of the valved species, but *V. crystallina* is stated to be 1—210″ in the length of its tube, or "lorica," as these tubes are absurdly called. Dr. Wright's *Vaginicola* is represented with a straight-sided cylindrical tube, and when the animal is retracted, the valve, as shown in the drawings, forms a conspicuous dark line slanting upwards "across the tube, commencing rather higher than half way up, and terminating on the opposite side between one quarter and one-fifth below the tube's mouth." When closed the valve is shown as pressed on one side of the tube.

The form of Dr. Wright's animal is like that of an ordinary Vaginicola when expanded, with the usual ciliated peristome and when retracted, it is shown as a long oval, pointed at the foot end.

I am not aware that anyone else has described a valved Vaginicola, and if not, the one now mentioned may be new. It was found on a sprig of myriophyllum, kindly given to me by Mr. H. Davis, with some specimens of the new rotifers discovered by him last year in a pond between Walthamstow and Leyton. In point of size it is much larger than *V. crystallina*, having a tube nearly 1—100″ long, and irregular in shape, as

shown in the annexed sketch. Part of these irregularities had the appearance of accidental dents, and the form of a perfect specimen might be nearly cylindrical with a rounded bottom.

Fig. 1.

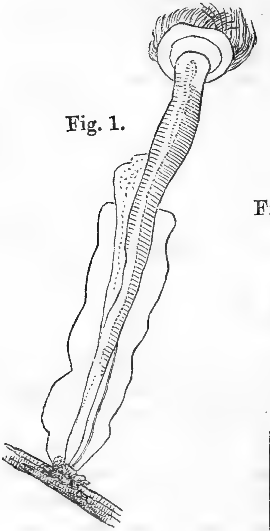
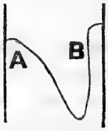


Fig. 2.

Fig. 3.



VAGINICOLA AQUATICA VALVATA.

The valve, or door, came close to the top of the tube, and was extremely delicate and transparent. The tube was inhabited by two animals, one larger than the other; the smaller one being probably an offspring produced by the fission of its parent. In retreating, the two creatures gave themselves a spiral twist, and both emerged together, shoving the door open before them. On their retreat, the door closed by the elasticity of a reduplicated portion, which acted as a spring. The diagram, Fig. 3, shows the nature of this construction. A is the door or valve, and B, the springy part, turned up against the side of the tube, and compressed each time the door was thrust back and opened.

The bodies of these creatures were finely striated in a transverse direction, and they contained numerous patches of green matter, like bright chlorophyll. The contractile vesicle was very noticeable, but the other organs were obscure, and an early loss of my only specimen prevented any detailed examination. The presence or absence of green globules can scarcely be regarded as indicative of specific distinction in creatures of this description, being probably nothing more

than the result of particular sorts of food. If the animal now described is new, it may be called *Vaginicola aquatica valvata,* thus distinguishing it as belonging to fresh water, and leaving open the question of whether it is to be regarded as specifically distinct from Dr. Wright's marine *V. valvata,* or merely as a variety, a matter not to be conclusively judged of without comparing a good many specimens.

Fig. 1 represents the animals protruded from their tube—one stretched to nearly its full length, and showing its ciliary wreath, the other only partially expanded. Fig. 2 exhibits them retracted with the spiral twist already mentioned. The valve, or door, is so delicate, as very easily to escape observation, except in those parts which have flocculent adhesions. Probably many more instances of valved forms may be discovered if the valves are carefully looked for. For this purpose, the illumination must be good, the light not too strong, and advantageously coming from an achromatic condenser. Excess of light or erroneous direction made the valve invisible in the specimen described, and the clearest portions could scarcely be distinguished in refracting power from the surrounding water.

Vaginicola aquatica valvata; tube approximately cylindrical, rounded at bottom, 1—100″ long. Animal much like *V. crystallina,* but bigger; when expanded, 1—50″ long, delicately striated transversely; retreating into its tube with a spiral twist. Valve reaching the mouth of the tube: when closed, slanting at about 45°. Valve consisting of a stiff plate of hyaline material, with reduplicated portion acting as a spring to close it.

BIELA'S COMET.

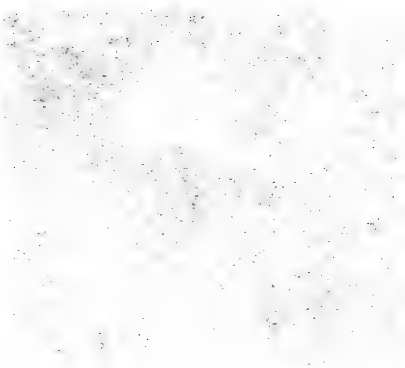
BY W. T. LYNN, B.A., F.R.A.S.,
Of the Royal Observatory, Greenwich.

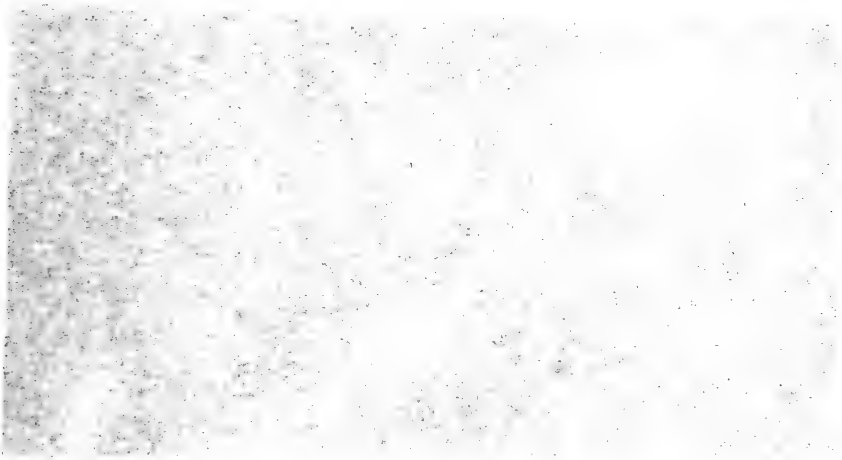
(*With a Tinted Plate.*)

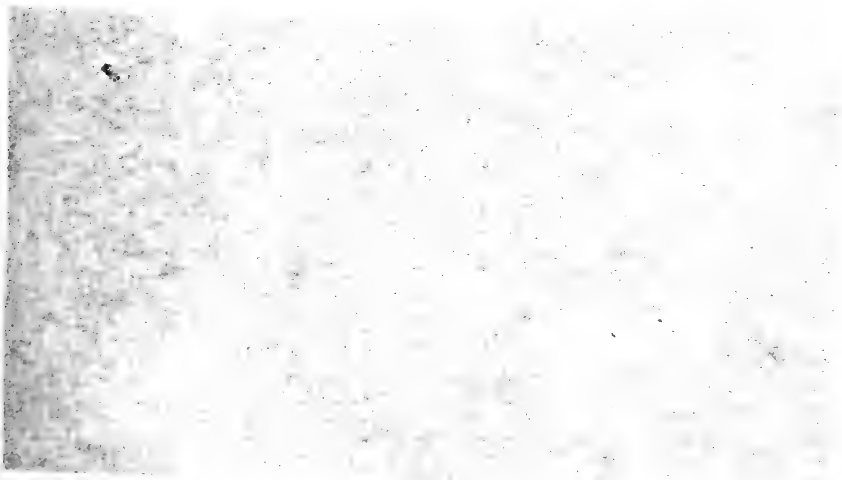
After performing the extraordinary feat of separating, twenty years ago, into two portions, this remarkable comet appears now to have vanished entirely; most vigorous and patient searches for it last year, at a time when it should have been conspicuous, having met with no success. The writer has been induced to think that, under these circumstances, an account of all the facts known concerning it, carefully digested into a small compass, would prove interesting, and, acting upon this belief, he has drawn up the following:—

On the 10th of November, 1805, this comet was discovered by M. Pons, at Marseilles, in the constellation of Andromeda. It was then a small comet, with tolerably defined nucleus, discernible by, but not conspicuous to, the naked eye. It afterwards increased in brightness and apparent size, and was observed by many astronomers, including Olbers, Schröter, Bouvard, and Maskelyne. According to the measures of Schröter,* the diameter of the nucleus on December 8 amounted to about 125 miles, whilst that of the spherical nebulous shell was more than fifty times as large, or nearly 6400 miles. That astronomer compared this proportion with that derived from his own measures of the comet of 1799. He found that the visible envelope of the latter was more than twice as large as that of the other, when each was at its respective nearest approach to the earth; and as the visibility of the successive layers of the envelope, since they always decrease in density in proportion to their distance from the nucleus, depends greatly upon the comet's distance, he concluded that the extent of that of 1799, which never approached the earth nearer than seventy millions of miles, was in reality far greater than that of 1805, which came within four millions of miles. Now, as the diameter of the nucleus of the comet of 1799 amounted to 1,500 miles, the cubical contents of that nucleus was about 1,900 times as great as that of the comet in question; hence the assertion appeared justifiable, that the mass and attractive force of the nucleus of a comet is the principal cause of the extent of its luminous envelope, which may be supposed to consist of attracted particles of ethereal matter. On the 8th of December, when the comet was nearest the earth, the former, which, from its then considerable southern declination, was observed by Schröter at no great

* *Berliner Astronomisches Jahrbuch* for 1809, p. 140.







BIELA'S COMET.

BY W. T. LYNN, B.A., F.R. [illegible]

Of the Royal Observatory, Green[illegible]

(*With a Tinted Plate.*)

[illegible] performing the extraordinary feat of sepa[illegible] [illegible] portions, this remarkable comet [illegible] now [illegible] entirely; most vigorous and [illegible] [illegible] at a time when it should have [illegible] [illegible] with no success. The writer h[illegible] [illegible] under these circumstances, an [illegible] carefully digested [illegible] interesting, and, acting [illegible]

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[illegible] nebul[illegible] fifty times as large, [illegible] [illegible] that astronomer compared this proportion [illegible] from his own measures of the comet of 1799. [illegible] visible envelope of the latter was more than tw[illegible] that of the other, when each was at its [illegible] approach to the earth; and as the visibility [illegible] layers of the envelope, since they always [illegible] in proportion to their [illegible] upon the comet's [illegible] con-[illegible] of 1799, which never approached the earth [illegible] millions of miles was in reality [illegible] within four millions of miles [illegible] of the comet [illegible] cubical contents of that nucleus was about [illegible] that of the comet [illegible] justifiable, that the [illegible] nucleus of a comet is the [illegible] luminous envel[illegible] [illegible] attracted partic[illegible] [illegible] 8th of [illegible]mber, when the [illegible] the former [illegible], from its [illegible] was observed by [illegible]

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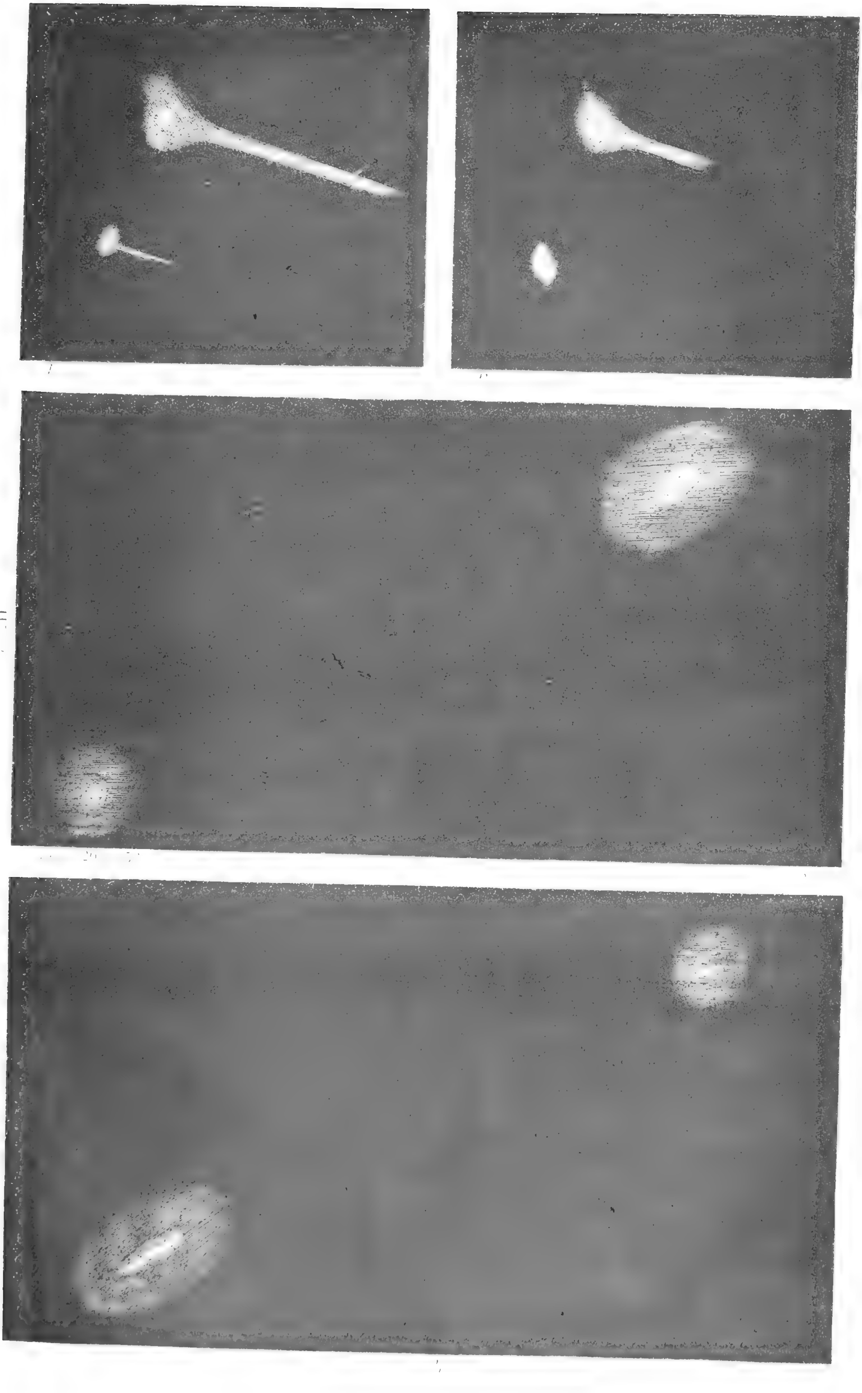


elevation above the horizon, appeared to the naked eye as a roundish, luminous, nebulous mass, nearly as large as the moon, and without any tail.

When the orbit of the comet was calculated, it was found that its elements were not very different from those of one discovered by Montaigne, in the year 1772. But more accurate investigations, made by Bessel and Gauss, on the supposition of an elliptic orbit, showed that the conjecture that the two comets were identical, was at least a very doubtful one. But, as Montaigne's comet had been very imperfectly observed (it was visible only for a very short time), Gauss remained of opinion that they were in fact one comet, with a period of about five years; though Bessel, on the other hand, was unable to assent to this.

We now come to the time when this remarkable comet acquired the name by which it has since been known. On the evening of the 27th of February, 1826, Biela, at Josephstadt, in Bohemia, discovered a comet which then appeared as a small round nebula, with a very fine point of light in the centre. Other astronomers afterwards observed it, of whom Gambert was the second, who independently discovered it at Marseilles, and says, "It has neither tail nor nucleus, but appears like a feeble nebulosity, the light of which is a little more intense towards the centre."* This was on the 9th of March. Harding observed it at Göttingen, having heard of it from Biela, and on the 14th of March perceived a small tail. The comet was in perihelion on the 18th of that month. At no time during this or any subsequent appearance was it visible to the naked eye; and it ceased on this occasion to be perceptible to the telescopes in the month of May. Biela himself† was the first who arrived at the conclusion, which all the calculators afterwards confirmed, that the comet had a period of about six and a half years, and was identical with that of 1805. He, indeed, suspected also that it might be the same as those seen in the years 1772, 1779, and 1812; but the latter two suppositions proved to be not tenable, and the former one continues, as we have already hinted, only a probability, whilst the identity of the comet discovered by Pons, in 1805, with this of Biela is an unquestionable fact. Thus, for the fourth time, was a comet's period of revolution round the sun satisfactorily determined, the three preceeding cases being those of the comets of Halley, Olbers, and Encke, whose periods are respectively 76, 74, and only $3\frac{1}{2}$ years.

* *Astronomische Nachrichten*, No. 92.

† He informed Schumacher that he had in fact partly expected it. Biela had already a cometic reputation, and had independently discovered a comet the previous summer, although on that occasion he was anticipated by Pons.

At this appearance the comet approached very near the earth's orbit; and it was calculated that, at the next, in 1832, it would approach still nearer. This proximity was, however, only to the *orbit* of the earth, which that of the comet intersected in such a manner, that when the comet itself crossed the ecliptic, on the 22nd of October, the earth was at no less a distance than forty-four millions of miles. But had the latter been then a month in advance of its actual place, it would have passed through the comet—"a singular rencontre," writes Sir John Herschel, in his *Outlines*, "perhaps not unattended with danger." The general public, indeed, received the announcement that the comet's orbit intersected the earth's, and that therefore, a collision was at some time possible, with feelings of considerable alarm. The celebrated Olbers showed that such a collision, or rather a very close approach of the earth and comet could, according to the laws of probability, take place, at the most, only once in about 2,500 years. Much to his chagrin, this expression was perverted, in many publications, into a very different one, that a collision between the earth and comet would actually take place at the end of 2,500 years from that time.

The first place at which the comet was seen in the year 1832, was at Rome, on the 25th of August, being detected early in the morning in the constellation of Auriga. This was by the use of the excellent ephemeris of Santini, who from that time has kept the comet under his protection. At the time of the discovery its light was feeble and nebulous, but by the 28th of the same month, it had considerably improved. The second observer was Sir John Herschel, at Slough, whose remarks must be given in his own words: "On the night of the 23rd, or morning of the 24th, of September, I observed Biela's comet, and again next morning (24th-25th), as it was then a bright object, and found without the least difficulty. I pursued it no farther, which I now regret, as I have not since heard of its having been seen so early elsewhere, unless, as it is said, at Rome, which, if verified, will be a great proof of the advantage of an Italian sky. But from the extreme faintness of it in the equatorial, on the 23rd and 24th of September, I can hardly imagine with what instrument this observation can have been made. I have since observed it on the 4th and 5th instant"* (*i.e.*, of October). By a "bright object," in the first sentence, Sir J. Herschel evidently meant comparatively to what he expected. Nicolai observed it at Mannheim, on the 21st and 24th of October, and describes it as being a small and excessively faint nebulous patch, only to be seen by great straining of the eye. Bessel also, who observed it at Königs-

* *Ast. Nach.*, No. 236.

berg, on the 20th of that month, states that a small star near it so enfeebled the comet by its superior light as almost completely to obscure it. The renowned Struve observed it at Dorpat, and on the 7th of November saw it almost centrally cover a star of the ninth magnitude. Later in November, the comet's light became somewhat greater and more condensed. At the Cape of Good Hope it was observed until 1833, January 3, by Henderson, who states that its brightness was only nearly the same as that of Encke's comet during part of its preceding apparition. It passed its perihelion on the 28th of November, 1832.

On its next return, in 1839, it was not seen at all, being too near the sun. But on the succeeding return, in the years 1845-6, those remarkable phenomena were seen which have ever since made Biela's so famous amongst comets. In October, 1845, Mr. Hind calculated an ephemeris from the elements of Santini, but he failed, notwithstanding great diligence, in being the first to detect the comet. An Italian sky again gave the priority to the observers at Rome, where it was seen by De Vico on the 26th of November; and on the 28th, Dr. Galle, at Berlin (the same astronomer who the year after was the first to see Neptune with the knowledge of its planetary character), also succeeded in perceiving it, close to the calculated place. It resembled an excessively faint nebula, and not till the evening of the 29th of November, when it was found to have moved according to the ephemeris, did the Berlin astronomers feel convinced that it was actually the expected comet. Encke himself declared that he should not have seen it had it not been pointed out to him, and for several nights he had to assure himself of its existence. Professor Challis observed it with the Northumberland telescope at Cambridge, on the 1st and 3rd of December.

On the 27th of January, 1846, Mr. Airy wrote to the Editor of the *Astronomische Nachrichten*—"Professor Challis has found, and the observation has been confirmed by Mr. Hind, that Biela's comet is double. Since I received notice of this, the weather has been excessively bad. It is evidently a thing which deserves the utmost attention of astronomers."* On the 29th of the same month, Encke wrote thus to the same periodical: "Biela's comet offers so remarkable a figure that I cannot help calling attention to it. Immediately on looking for it with the smaller 3½-feet Dollond, d'Arrest found that the comet consisted of two completely separated cometary nuclei. This was on the 27th of January. In the refractor it appeared the same. The fainter nucleus is to the north of the other. There is in both a trace of a tail, its direction being

* *Ast. Nach.*, No. 553.

in both perpendicular to the line connecting the two nuclei. The first conjecture was that we had a second comet or a nebula. But they move together with equal velocity, and in the same direction." Challis appears to have been the first European observer of this extraordinary appearance, on the 15th of January. Sir John Herschel observed it on the 28th, and remarks, "What surprised me was the roundness of the almost detached nebula, and its distance." Bessel, at Königsberg, remarked the change the same day as Professor Challis. The day before (January 14th), he states that he saw nothing unusual in its appearance, but on the 15th, the air being clear, and the moon not yet risen, he saw quite distinctly two separated nuclei, the one from three to four times as bright as the other. News afterwards arrived from America that this extraordinary phenomena had been seen at Washington as early as January 13th, by Lieutenant Maury, who then thought, like Encke, that the smaller nucleus was a nebula, or fainter comet near Biela; but on January 14th, observing before moonrise, he wrote in his note-book, "Biela has a companion close aboard! The acolyte is about as faint as Biela was in the moonlight of the 12th. Looking through the corner of my eye, I can catch glimpses of a tail to each. Biela's tail reaches off N.E., and his companion's is nearly parallel with, but slightly inclined towards, it."* The first suspicion of anything unusual was expressed by Mr. Hind, who, on the 19th of December, 1845, described the comet as being "somewhat elongated, or pear-shaped," but that circumstance, he tells us himself, was merely mentioned as a passing notice, such distortion being not unfrequently noticed in telescopic comets.†

Both divisions continued to travel together at very nearly the same real mutual distance, although from their respective visual positions, the apparent distance considerably increased. The actual distance, however, from the beginning of February until the middle of March, continued to be about 150,000 miles. Meanwhile, some very extraordinary changes of appearance manifested themselves. Whereas, at the time of separation, the new, or companion comet, was extremely small and faint in comparison with the other; this difference gradually diminished until, on the 10th of February, the two were nearly equal. Afterwards, the new comet gained a decided *superiority* of light over the old, presenting also a sharp and star-like nucleus. This, however, lasted but a few days, the original comet re-asserting its superiority, and becoming, by February 18th, nearly twice as bright as its companion, which now began to fade away, and ceased to be visible after the 15th of March, although its originator was

* *Ast. Nach.*, No. 561. † Hind's *Comets*, p. 77.

seen until nearly the end of April. Another curious phenomenon was noticed in America in February. The companion comet, besides its tail, extending in a direction parallel to that of the other, threw out a faint streak of light, like a bridge, towards the other, whilst the latter threw out additional rays, presenting the appearance of a cometary nucleus with three tails, one forming an archway of cometary matter extending to the nucleus of the companion comet.

The comet was also observed after its division by Otto Struve, with the great refractor at the magnificent observatory at Pulkowa, in Russia, of which place his distinguished father, Wilhelm Struve, was then Director, and in which, since his father's death, he has so worthily succeeded to his office. From his observations on the 19th and 21st of February, the drawings were made, representations of which are given in Figs. 1 and 2 of our Plate. They show the change in the appearances of the two nuclei during that short time.

At this return the comet's perihelion passage took place on the 11th of February. The last day it was observed was on the 27th of April, by Professor Argelander, at Bonn, near Cologne.

Of course its next apparition was eagerly expected, though, from its position on that occasion, it could only be visible for a short time. Again was it first seen at Rome; this time by Father Secchi,* on the 26th of August, 1852, at about half-past 3 o'clock in the morning. Shortly after that hour, it centrally covered a small star of the 9-10th magnitude, producing the appearance only of a slight nebulosity surrounding the star. On the morning of the sixteenth of September, the same astronomer saw also the separated companion comet: it was very faint, without nucleus, and of elongated figure, the elongation being on the opposite side to the sun. The observation was altogether very difficult, because, almost as soon as the comet got out of the mists of the horizon, its light was enfeebled by the increasing twilight. Two nights afterwards it was observed at Berlin. Subsequently it was seen at Cambridge: the shape was elongated, but the companion was not perceived. There was, however, another witness of the continued duplicity, namely, Otto Struve, who again observed the comet with the powerful refractor at Pulkowa, near St. Petersburg. He first saw it on the 18th of September, but could then only perceive one of the nuclei, which proved to be the northernmost of the two, and *not* the one first seen at Rome, which was the only one observed at Cambridge, so much had the relative brightness changed. Struve describes it as being in amount of light about equal to a star of the 8-9th magni-

* *Ast. Nach.*, No. 822.

tude, with scarcely a decided nucleus, but a condensation of light towards the centre. Two days afterwards (Sept. 20) the nucleus had become decided, and that of the other division of the comet was also perceived, of scarcely inferior brightness. Fig. 3 gives a very correct representation of a drawing made by Struve on that day. On September 23rd the nucleus of the fainter comet, or division of comet, was hardly perceptible. On September 25th, another drawing was made, represented in Fig 4. The brighter comet was now oblong in shape, the other much fainter. On repeating the observation on Sept. 28th, the second nucleus, or the one first seen at Rome, was not distinguished at all; the other was seen and observed with some haste, because of the increasing twilight. This was the last observation made anywhere.* It must be remarked that the mutual apparent distance of the two nuclei was considerably greater than in 1846. The distance, however, of the comet from the earth was about twice as great as when it was in perihelion in that year, viz., 126 instead of 56 millions of miles.

At the next return to perihelion, in 1859, the comet was too near the sun to be seen. It cannot, therefore, be said whether it *did* return or not.

The next appearance, in 1865-6, was most eagerly expected, and the comet was most diligently looked for at nearly all the great observatories, but, to the great disappointment of astronomers, it was nowhere seen. The conclusion from the failure of these attempts to recover the lost wanderer, seems to be, that it is completely dissipated; and this conclusion Professor d'Arrest, who devoted with great zeal, on every possible opportunity, the fine instrument he now has at his command at Copenhagen to the search, has not hesitated recently to express with considerable confidence.† This dissipation we may presume to be a consequence of the same feebleness of attraction which, in 1846, caused its separation into two portions. And yet it was with this dispersed, scarcely-cohering matter, that all Europe, in 1832, was alarmed at the possibility of a collision. Again and again has astronomy been asked whether she can indicate the means whereby the Almighty will one day accomplish the destruction of our globe? Again and again has she answered in the negative. There have also been those who have demanded of her the steps by which He was pleased to create this scheme of things, this beautiful system, this wondrous kosmos of which our earth and our-

* *Memoires de l'Académie Impériale des Sciences de St. Petersburg.* Sixième Série. Sciences Mathematiques et Physiques, Tome VI.

† *Ast. Nach.*, No. 1624. A translation by myself is given in the *Astronomical Register* for March 1867.

selves compose parts. Theories have been formed from astronomical facts, but such theories have always been deficient in anything like firm foundation, in aught but a kind of plausibility. The one solid answer remains alone in all its grand simplicity—"He spake, and it was done; He commanded, and it stood fast."

FRESH NOTES ON THE CRATER LINNÉ, AND SUPPOSED LUNAR ERUPTIONS.

The *Astron. Nachr.* publishes a letter from Schmidt, in which he says, that "at the time of Lohrmann's and Mädler's work, from 1822—32, Linné was more than 5000 toises wide, and had a very deep crater, plainly visible as such, and when near the phase, more or less in shadow. It was the third in size of *M. Serenitatis'* craters, and was seen and described by Schröter in 1841—3, and by me." What seems deficient is, positive evidence of the crater-form appearance of Linné, at a more recent date—say shortly before 16th Oct., 1866, since which, Schmidt states that no crater has been visible. His words in this letter are: "At least since Oct. 16th, 1866, the crater form of Linné at a time of oblique illumination cannot at all be recognized, (*durchans nicht warhgenomnen werden*). The Athens refractor shows at times in the interior a fine black point (*feinen schwarzen punkt*), 300 toises (1918·4 English feet), in diameter."

Schmidt further observes that in high illuminations Linné is always visible as a light spot, and has been so for more than twenty years; and then comes the following passage, which should be considered in connection with the following letter of Secchi's to the French Academy, and with the fact that several English observers have noticed a more or less distinct black spot.

"If strong eye pieces of 500 to 1000 times magnification occasionally give indications of a crater-form, it is especially necessary to state whether such crater is deeply shadowed, and has the old diameter. If such were the case, at present, large telescopes would not be necessary, and the questions now raised would not have been propounded."

Schmidt further states that he has satisfied himself by observations during four lunations that Linné is now "never to be seen as a crater of the normal type."

At a recent meeting of the Imperial Academy of Vienna, Herr Haidinger read a letter from Schmidt, detailing sundry

facts which are already in the possession of our readers, and treated the appearances presented by Linné as the first proof furnished with perfect certainty of a change in the moon's surface. Herr Haidinger likewise read a second letter from Schmidt, which we give, as translated by W. J. Lynn, Esq., F.R.A.S., from the *Cologne Journal*:—

"An eruption of vapour or ashes is not probable, because a shadow of that which covered the crater would be thrown at sunrise and sunset, but this is never the case; such must *also* be visible at the phase, which is not the case. Had the crater sunk below, in its place a great shadow *would* be visible during the phase. Had the ring-mountain been destroyed, the fragments would throw shadows, which also is not the case. Had the crater been filled up by an eruption of fluid or powdery matter, without overflowing, the interior black shadow at sunrise and sunset would indeed disappear, but there would remain a hill, throwing a shadow on the outside. This was the appearance seen by Schröter in 1790, in the central crater of Posidonius, and by Julius Schmidt, in the same object, in the month of February, 1849. But such a mass of matter may also have flowed out over the outside banks, and covered the surrounding declivity, with very gradually sloping inclination. This would prevent the casting of a shadow outside at the phase. Such an event would explain all the phenomena presented by Linné, and it is the kind of event which in the mud volcano of the peninsula of Taman, so closely described by Abich, has so striking an analogue upon our earth. The spreading of the overflowing bright mass over the dark plain gives occasion to the origin of broad formations similar to a halo, which are frequently seen upon the moon, especially in the so-called '*Maria*.' Here lies the key to new enquiries and points of view; a hope for the future."

"Herr Schmidt had already received information from Mr. W. R. Birt, of London, one of his correspondents, that the latter had also confirmed the fact of the disappearance of the crater Linné, and that an account thereof had been communicated, by a circular of the Lunar Committee, to astronomers interested in it."

"The long and indefatigable exertions of our highly-honoured friend, Julius Schmidt, have therefore been crowned by a result for which even Mädler, although he did not resign the hope, remarked, however, that although he had laboured to discover traces of changes on the moon's surface, he was obliged to confess that all the labour hitherto spent upon that object had led to no positive result." (*The Natural Sciences, etc.*, vol. iii. p. 573.)

"What agonizing interest would this event have given to our

immortal Humboldt, who, in his *Kosmos*, places together in their order, Lohrmann, Mädler, Julius Schmidt, for their instructive and original labours upon the moon (for example, in vol. iv., pp. 614 and 615) and who constantly took interest in, and recognized with pleasure the value of the results of the labours of the latter."

"Our readers will peruse with interest the following

REMARKS ON THE ABOVE BY W. R. BIRT, F.R.A.S.

"One of the most important features in the above sketch of hypotheses is that of the mud-volcano being the terrestrial analogue of the phenomenon recently observed on the *Mare Serenitatis*. As Dr. Schmidt very justly remarks, the appearance presented by Linné receive an explanation on this view. In the very interesting paper on the mud-volcanoes and salt lakes in the Crimea, by Professor Ansted (INTELLECTUAL OBSERVER, vol. viii., p. 409) it is recorded—the well-known naturalist, Pallas, being the authority—that in the year 1794, on the 27th of February, from the cone near the delta of the river Kuban, large quantities of mud were thrown out, accompanied by flame, which continued half an hour, and rose to a height of 150 feet above the ground. The height of the cone was 250 feet. The mud thus thrown out is said to have spread over the plain, but the rapid eruption was soon over. Twenty years afterwards, Engelhardt mentioned two craters, each about 50 feet in diameter. At present, after a further interval of more than fifty years, the vent is nearly closed up, although the cone rises at least 250 feet above the plain of the delta, and possesses a crater of a very distinct form.

"It is highly probable that the eruption in Linné was *sudden*, and, taking into consideration the size and depth of the crater, a very considerable quantity of matter must have been injected from below. In my former remarks on the phenomenon (INTELLECTUAL OBSERVER, vol. x., p. 444), I suggested that the crater itself had been concealed, but it appears from Dr. Schmidt's, as well as from the English observations, that the crater is not only actually *filled*, but that a hill of nearly 2000 English feet in diameter, and about 40 feet high, exists where a deep cavity was formerly seen.

"The fine black point and white summit are interesting, and are features which should be most assiduously watched, especially by means of large apertures. Mr. Webb (see INTELLECTUAL OBSERVER, vol. x., p. 442) records the discovery of a minute pit on the summit of a mountain north of Aristotelis. Of the recent formation of the hill—*we may now say*—on Linné,

there can be no doubt, it having been recorded by several observers. I also mention (INTELLECTUAL OBSERVER, vol. x., p. 445) a somewhat similar object on the Mare Crisium, west of Picard. The evanescent or permanent character of these and similar objects it would be well to determine. In his last communication to me, Dr. Schmidt mentions a faint, light tail, of about 4·6 English miles in length, perhaps analogous to the streaks from Messier. This he did not remark until Jan. 24, 1867. It may have originated from a further overflow of the matter filling the crater. This also is an object deserving of attention.

"The similarity of the reflective power of Linné under a high illumination, both before and after the change that has taken place, is curious. It appears to indicate that whatever may be the nature of the injected material, its reflective power is much the same as that of the interior surface of the former crater during the last 20 years; and, comparing it with the records which we have of the former brightness of Linné, *the reflective power has declined of late years.* (INTELLECTUAL OBSERVER, vol. x., p. 446.)

"Connected with this subject, we find—very extensively indeed—scattered over the moon's surface, especially at the time of full, both small and large bright spots, some of which, when near the terminator, are seen as craters; while others, even under the greatest amplification, exhibit nothing whatever of the crater-form. The Rev. W. R. Dawes notices spots of this nature in his interesting description of the small craters which he observed on Plato in January and April, 1863 (*Monthly Notices of the Royal Astronomical Society*, vol. xxiii., p. 222). It would be well for observers carefully to watch from time to time these bright spots, especially as we have now a veritable instance of the formation of one, which possibly may undergo further change, and it is not unlikely that changes may be detected in some others. As a large number of these bright spots are found on the *Maria*, monographs of the craterology of each *Mare*, such as I have attempted for the *Mare Crisium*, would be very valuable. See *Report of the British Association for the Advancement of Science*, 1865, p. 292."

PRODUCTS OF VOLCANIC ACTION.

With a view to facilitate a comparison between lunar and terrestrial volcanic action, the following facts and considerations may be useful.

Volcanic action on the earth results from a highly heated condition of large masses of matter below the surface of the globe; but it is not necessarily, or even probably, directly connected with a great internal molten sea, such as many geo-

logists imagine to exist beneath the solid crust of our planet. The depth of earthquake movements, or rather, of the focus of earthquake disturbance, has been investigated by Mr. Mallet, in his work on the Neapolitan earthquake of 1857,* and from mathematical considerations, applied to actual observations, he arrived at the conclusion, "that out of twenty-six separate wave paths, twenty-three started from the seismic vertical, at a depth of about $7\frac{1}{8}$ geographical miles, or of 43,284 feet. The maximum depth is $8\frac{1}{8}$ geographical miles, or 49,359 feet, and the minimum depth is $2\frac{3}{4}$ geographical miles, or 16,705 feet. Eighteen of the wave paths start from the seismic vertical within a vertical range in depth of 12,000 feet, and having a common focal depth of $5\frac{3}{4}$ geographical miles, or of 34,930 feet, which may be taken as the depth of the focus. The extreme vertical range between maximum and minimum depth is 32,654 feet. On examining the diagram, however, having regard to the points in the seismic vertical where the wave paths start thickest, it will be apparent that the probable vertical depth of the focal cavity itself does not exceed 3 geographical miles, or 18,225 feet at the outside."

Applying the same principle of calculation to the larger earthquake phenomena of South America, he considers that the greatest probable depth of earthquake action is somewhat less than thirty-one geographical miles, and, "therefore, only just touches the depth which upon received notions, as to the increment of hypogeal temperature, is supposed to form the upper surface of the imaginary ocean of liquid lava of the earth's interior."

The connexion between earthquakes and volcanoes is generally admitted, and though earthquakes frequently occur at considerable distances from volcanoes, an eruption of the latter usually acts as a safety valve, and lets out highly-heated materials which would otherwise, by their efforts of expansion, produce tremendous shocks. Volcanoes, like earthquakes, may result from chemical actions at the moderate depths spoken of by Mr. Mallet, and if this is the case on the earth, it may be so likewise on the moon.

On the earth, the magnitude of volcanic forces, whether exhibited in eruptions or earthquakes, seems to stand in frequent, if not constant relation to the height of mountain chains, and the depths of the *foci* of disturbance probably vary considerably, as Mr. Mallet suggests. If we apply this principle to the moon, Linné would be connected with the volcanic district of the Caucasus and the Apennines, which are amongst the highest of the lunar chains, the former reaching an extreme elevation of 17,138 Paris feet, and the latter of 16,934 Paris feet, or one-

* *First Principles of Observational Seismology.*—Chapman and Hall.

twelfth more English feet, and would therefore be very nearly, if not quite in a region of maximum volcanic force.

The moon offers no *positive* evidences of having had its surface modified by aqueous action, and if no such action has occurred on an extensive scale, the appearances presented may be those of a much more primitive condition than are now found on our earth. The larger craters may date back to a period of igneous plasticity, and eruptive action may now be on a much smaller scale, and also more local in character, than it was in former ages when the surface was less solid, and the heat below the surface more equally diffused and more intense.

The matters erupted by terrestrial volcanoes are vaporous and gaseous as well as solid, and water frequently occurs in what are called "igneous rocks." Following Cotta's division,* such rocks are arranged in the two classes, *volcanic* and *plutonic*, the former comprehending such as "have solidified at or near the surface, and the latter those which have solidified at a considerable depth in the interior of the earth."

Taking the whole range of igneous rocks, Cotta gives the following "extreme average values of their chemical constituents":—

Silica	50—80
Alumina	10—25
Peroxide and protoxide of iron .	1—25
Lime	0—15
Magnesia	0—12
Potash	0—10
Soda	0—7
Water	0—5

Another division of igneous rocks refers to their being richer or poorer in silica, which behaves like an acid. Those most rich in this constituent are called *acidic*, and those less rich *basic*, and both kinds frequently contain small quantities of water.

When terrestrial eruptions occur, vapours of water, sulphur, etc., and gases, are abundantly emitted. In the words of M. St. Claire Deville, "lava never flows forth without bringing with it immense quantities of gaseous matters and vapours. These last may, indeed, appear singly, but everything indicates that they escape from stony masses in fusion situated more deeply."† Water coming into contact with such masses must be immediately converted into high pressure steam; and wherever large quantities of vaporized substances are emitted,

* Cotta's *Rocks Classified and Described.*—Longmans.

† *Comptes Rendus*, No. 26, 1866.

their condensation, as they become cooler, gives rise to the great masses of cloud and smoke which form so striking a feature in most eruptions. Water is acknowledged by all authorities to play a very important part in all, or nearly all, varieties of terrestrial volcanic action, and if the volcanoes of the moon perform their functions without its assistance, they must differ widely from those of the earth.

The supposition of a mud volcano in the moon includes the belief that water exists in that body in cavities below the surface, if not upon it. But if water is poured forth in company with solid matters, might we not expect to see clouds and vapours? If the moon has no atmosphere, as is commonly asserted, evaporation from mud or water emitted by a volcano would be very rapid, and if the total quantity was very small, condensation would be inconspicuous even when the lunar temperature declined during the evening and night of our satellite.

The appearances of Linné are such, that if we are satisfied it was an empty hollow, or crater, a few years ago, we must regard it as having been filled to overflowing with some erupted material. If mud, then much vapour might be expected. If liquid lava, vapour and cloud would, we should suppose, have been formed at the time of the eruption, unless lunar volcanoes differ in their action from those of our earth, or the absence of an atmosphere causes instant evaporation, and precludes noticeable condensation. Actions of this kind might impair the visibility of particular objects while they were in process.

There are on the moon an immense number of spots, much resembling the present appearance of Linné; and if they had a similar origin, what are we to suppose has become of all the water vapour that must have been poured forth upon the mud hypothesis? Under the receiver of an air-pump, Dr. Miller states, that water may be made to boil at a temperature of 70°,* and Sir John Herschel thinks it possible that, during the lunar day, the moon's surface "may *possibly* be heated to a degree much exceeding that of boiling water."

Sir J. Herschel also says that we are entitled to conclude the non-existence of an atmosphere one 1980th part as dense as that of our earth, as the presence of such an atmosphere would give rise to a refraction that would be observed during the occultation and reappearance of stars. Under such circumstances, if any great quantity of water has at various times been poured forth by volcanoes from internal cavities, it must have been rapidly absorbed, and held fast by chemical action, or an atmosphere of vapour would be detected.

* *Elements of Chemistry.*

Secchi on Linné.

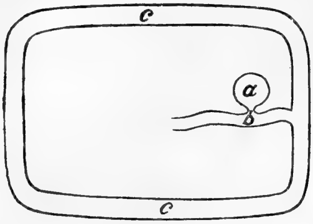
Father Secchi has sent to the French Academy a letter dated from Rome, 14th Feb., 1867, in which he says, "On the evening of the 10th, between nine and ten o'clock, the crater (Linné) entered into the sun's light, and close by the limiting circle a small prominent point was seen with a little shadow, and round this point an irregular circular corona, very flattened. The weakness of the light and the proximity of the moon to the horizon did not allow the observations to be prolonged. On the 11th, in the evening, Linné had already advanced into the light, and at seven o'clock, a very small crater was distinctly seen, surrounded by a brilliant white aureole, which glittered against the dark ground of *M. Serenitatis*. The size of the orifice of the crater was at most $\frac{1}{3}$ of a second, and the aureole was a little larger than Sulpicius Gallus. I insist on this comparison because it shows that Beer and Mädler could never have figured a crater as big and as well-marked as that which they assigned to Linné, for the white spot which at present exists; in fact Sulpicius Gallus is actually much larger than the little crater which forms the centre of the spot. This last is even smaller than those craters which are indicated merely by letters, without names, and which are distributed at great distances in *M. Serenitatis*. It cannot be doubted that a change has taken place, and it seems probable that an eruption has filled the ancient crater with a material white enough to look bright against the dark ground of the sea."

ARCHÆOLOGIA.

Among several discoveries of Anglo-Saxon cemeteries announced within the last few weeks, one appears to present some features of special interest. In the parish of Woodstone, within a mile of the city of Peterborough, a spot was dug for the purpose of obtaining gravel, in the course of which operation about twenty skeletons were disinterred, accompanied with the usual objects found in the Anglo-Saxon cemeteries, especially within the limits of East Anglia. Among these are to be remarked the cruciform fibulæ, of which there were a certain number, but of rather plain design. Among the circular fibulæ some were saucer-shaped, a class which is now considered to have been peculiar to the West Saxons, and therefore the circumstance of finding them in a cemetery in the neighbourhood of Peterborough is worthy of remark. Other round fibulæ were mere round plates of bronze, but with simple and rather peculiar ornament, with hinges on the reverse side. Bosses of shields, small spear-heads, and knives, were found in abundance, but not a single example of the long sword. Among other objects were several small buckles, and many beads in amber, earthenware, and glass, the latter chiefly green and blue. We have often had occasion to remark, that among our early Anglo-Saxon forefathers beads were worn by the men equally with the women, and we have found more than once a regular necklace round a man's neck. Perhaps they were considered as carrying with them something of dignity, as well as being objects of finery. We are informed that in one case, in the cemetery found at Woodstone, a string of beads was suspended across the bosom, one end attached to a fibula on each breast. The bodies appear to have been all interred entire, whereas cremation and urn-burial appear more usually to have prevailed among the Angles. They lay for the most part east and west, but some lay exactly north and south. Two urns of earthenware were found, but they were plain, and without ornament or pattern.

The exploration of the Treveneage Cave, near Penzance, has been concluded for the present; chiefly, we fear, because the funds in hand were expended. Among the miscellaneous objects last turned up was an earthenware spindle-whorl, an object much more rarely found of this material than of stone. It resembles, in appearance and size, one of similar material figured in Sir John Lubbock's *Pre-historic Times*, which came from a Swiss Lake-dwelling. Many more fragments of pottery also have been found, but not a sufficient number of any one suite to form a complete vessel, though the shape of three have been tolerably well determined by the fragments. One of these, about nine inches in its greatest diameter, made of fine light brown clay, highly finished on the wheel, and glazed black without, is evidently Roman. The second, which is fifteen inches high, of rather coarse clay, and also wheel-formed, is of a form which is not very characteristic of a period, but appears to be copied from Roman. The third, which is glazed black on both sides, suggests strongly the notion of Anglo-Saxon.

They all give us the notion of their being rather late Roman, or of the period immediately following, but to what kind of settlement they belonged here it is very difficult to guess with the extent of our present knowledge. The cave is contained within an area surrounded by a ditch or fosse, and containing about half an acre of ground. Its position, and the passage from which it was entered, will be best understood by the slight plan here given, where *a* represents the cave, *b* the passage, and *c c* the ditch of inclosure. Numerous fragments of bones were found in the cave, some evidently belonging to a large animal, but in general they were so much calcined that it was difficult to decide upon their character. Some fragments were supposed to be human, and the directors of the excavations appear to be inclined to the belief that the cave has been at some time used for sepulchral purposes.



A short time ago, the remains of a ROMAN VILLA were uncovered near TRACY PARK, in the neighbourhood of Bath. The farm on which it was situated was named Cold Harbour, a name often found attached to Roman sites. At a recent meeting of the Bath Natural History and Antiquarian Field Club, the Rev. Prebendary Scarth gave an interesting account of the discoveries made in the course of the excavations. Before they were undertaken, numerous fragments of Roman pottery, tile, and cut stone, were seen lying about an arable field adjacent to the pasture field in which the villa stood; and in the next arable field are the remains of an ancient cromlech, two upright stones of which now only remain, although within memory there existed a third, and the whole was capped by another large stone. All these remains, as we understand, were inclosed within a rectangular earthen boundary, inclosing a space of about two acres. Walls within were soon traced, running at right angles, and the excavations, as they proceeded, disclosed no fewer than thirteen or fourteen rooms upon the same level, two of the floors of which had been provided with hypocausts. The floors had been broken up and destroyed, but some of the tessellæ were scattered among the earth, and part of the columns which had supported them, which had been made of bricks of the usual height and form, though older materials had also been used up along with them, and the portion of a pilaster, or small column, was found employed as one of the supports. Prebendary Scarth inferred from this that the villa had been, at some epoch, rebuilt or enlarged, and, as one side of the pilaster was weather-worn, it seemed to have formed part of a building of earlier date. At the south-eastern angle of the villa, when the walls had been traced to their limit, a stone water-course was laid bare, and followed until its outlet was ascertained. At the south-western end, the paved court was found, which had contained within it a small garden, probably for flowers. On the north side of the larger hypocaust was found a solid block of masonry, which

Prebendary Scarth thinks may have been the basement of an elevated part of the building, such as we find preserved in the wall-paintings preserved at Pompeii, and which appears to have consisted usually of a square turret, from which the whole of the farm-buildings could be over-looked. This arrangement, he adds, is followed to the present day in Italian villas, and we find the same in mediæval buildings, as at the abbot's house at Wenlock, Salop, and in the Deanery at Wells. The usual relics found on the sites of Roman buildings were met with in abundance, such as tiles, roofing slates, fragments of frescoes from the walls, and a portion of the leg of a small marble statue; as well as abundance of pottery, including Samian ware; good specimens of glass; bones of animals, and tips of the antlers of deer, some bearing marks of the cutting tool, and bone hair-pins, and other small objects. As usual, oyster-shells were found scattered about. The coins, which were all of copper, with the exception of one silver one, were numerous, and ranged from A.D. 270 to 455, the latter a very late date for a Roman coin found in Britain, and Mr. Scarth thinks that we may conclude from it that the villa "was occupied by a Romano-British master till the time of the Saxon conquest, when it shared the fate of the many Roman villas which once stood around Bath." This villa, he considers, from the appearance of the remains, to have formed a plain oblong, similar to that found at North Wraxall. Remarks were made by several of those present at the meeting, chiefly on questions relating to the cultivation of gardens by the Romans in Britain, and on the use of window-glass. Now, however, so many examples of window-glass, thick and thin, have been found on Roman sites in this island, that there can be no doubt whatever of its having been in use here in Roman times. The cromlech, too, was a singular object to find in this juxta-position with a Roman villa, and caused considerable surprise. One of the speakers suggested that it was the dog-kennel of the house.

Much has been heard of late of the forgery of antiquities, and especially of FORGED FLINT IMPLEMENTS, for which East Yorkshire has become rather notorious. Some interest has just now been excited by the circumstance that the principal, if not sole author of these forgeries, whose name was Edward Simpson, of Sleights, near Whitby, but who was better known by the nickname of "Flint Jack," and sometimes by that of "Cockney Bill," has just been convicted of theft at Bedford, and is now confined in Bedford gaol for twelve months. Forgery of this kind is, of course, closely allied to dishonesty of all other kinds. In a recent number of the *Malton Messenger*, the history of this man's career appears to be traced still farther back, and Simpson appears not to have been his original name, but he is stated to have been first known as Jerry Taylor, and to have been a small farmer, residing at Billery Dale, the scene of his earlier forgeries, which he had been in the habit of carrying to Whitby for sale, for some years previous to 1855. He also took to forging British urns, and so cleverly, that many people were deceived. We are told that, under his name of Cockney Bill, he one day sold some urns to a gentleman at Bridlington, one of which fell out of

the purchaser's hands, and was broken into fragments. Cockney Bill took the pieces home, returned the urn perfect, and was rewarded for his trouble. A few days afterwards, in sweeping the corners of the room where the urn fell, a large portion of the bottom and side of the original urn was found. This opened the gentleman's eyes, and convinced him that Cockney Bill was an imposter. One of this man's chief occupations was collecting fossils, and even in this he is said to have become notorious for his deceptions.

The newspapers announce, after some of the local papers, apparently interesting discoveries of ROMAN REMAINS brought to light at CIRENCESTER. In excavating for some works at the New Cattle Market, the excavators came upon what had evidently been part of the Roman cemetery, and dug up two rather small stone sarcophagi, each containing the remains of a child, and three sepulchral urns, containing burnt bones. In one of the urns several objects were found, including a terra-cotta lamp, ornamented with figures, what is described in the newspaper as "a safety-pin, on the same principle as those in use at the present day," a bronze fibula, four coins, and one of the small glass unguent bottles, commonly called lachrymatoria. In another part of the town, some men engaged in excavating for cellars, on land in the New Road, came on what is described as the remains of a hypocaust, and found a number of small works in metal and bronze, and other relics of the Roman period. It is to be hoped that some more careful and intelligent account of these discoveries will be published. T. W.

PROGRESS OF INVENTION.

THE OXYHYDROGEN LIME LIGHT.—The applicability of this very brilliant light is greatly limited by the very considerable size of the reservoirs required for the gases, and the cost of the latter. An ingenious American appears to have very much lessened, if not removed, these difficulties. He uses for reservoirs iron cylinders capable of sustaining very great pressure, and condenses each of the gases into that one destined for it. Gasholders of this kind, able to sustain a pressure of fifty pounds to the square inch, and large enough to hold each fifty cubic feet of gas, are of a very moderate size and weight. Cylinders two and a half feet long and nine inches in diameter cost about a dollar for every fifteen pounds to the square inch pressure they are capable of sustaining. They can be filled with the gases at a very moderate cost; with oxygen at the rate of little more than a shilling per cubic foot, and with hydrogen at one-tenth of that price. He has also improved the jet used for burning the mixed gases. The compactness of this apparatus promises to greatly extend the sphere of utility of the oxyhydrogen lime light, the appliances for which have hitherto been so cumbersome and inconvenient.

NEW MODE OF CONSTRUCTING BARRELS.—It is difficult to prevent

ordinary barrels from leakage when filled with certain liquids, and this imperfection very often, as for example in the case of the petroleum and coal oils, is not unattended with danger. Barrels are now formed in the oil districts of America which are free from all imperfections of this kind; while, at the same time, they are light, strong, and inexpensive. They are formed by wrapping spirally round a mould, representing the interior of the intended barrel, strips of white oak, and crossing them with other slips, that are attached to them by a glue which is adapted to the purpose. This process is repeated until the requisite strength and thickness are attained, which, in ordinary cases, is when there are twelve or fourteen layers thus crossing and attached to each other. The heads are formed in a similar way, and are firmly united to the bodies.

Step for Shafting.—A serious mechanical difficulty is experienced on account of the great pressure which is sometimes exerted against the step in which an upright shaft revolves. The friction produced, and the heat by consequence developed, has often led to the welding together, or the fusion of the metals, notwithstanding the attention paid to lubrication. This inconvenience exists whenever a thrust is exerted by the shaft, in whatever direction that thrust may be, whether upwards, downwards, or laterally; and hence great difficulty has arisen in making suitable provision for resisting the thrust of the screw shaft, where, by acting within the vessel, it gives rise to propulsions. Many contrivances have been proposed, and several have been used to meet the difficulty. A recent, and apparently a very effective, invention, intended for this purpose, consists in making the end of the shaft play against chilled iron balls placed in a cup-shaped receptacle. The end of the shaft is so formed that it acts on the balls at an angle of 45°, and presses them against the rim of the chamber which contains them; and it is so arranged, that the difference between the diameter of the circle they traverse and the rim is such as to give rise to a uniform rotation, and therefore to a uniform wear and tear. This contrivance appears particularly well adapted to the steps of turbines, which, when the column of water is high from the great pressure sustained and the enormous velocity of rotation, present very great difficulties in this respect. To a certain extent, indeed, the impossibility hitherto of obtaining a suitable step has set limits to the height of the column of water that may be utilized by them. Should this contrivance be found to answer, as the rubbing is changed into a rolling friction, the difficulty will be entirely got rid of.

Preservative Coatings for Metals.—One of the most effective modes of preserving the common metals consists in coating them with a thin film of gold or platinum. This, however, is attended with expense and trouble; and the same object may be as well, if not better, attained by coating with oxides. For this purpose, however, it is indispensable that the oxides should be made to adhere with great tenacity, a circumstance which long prevented the preservative qualities of oxides being fully utilized. The oxides of iron and lead are the most suited for preservative coatings, especially as they are capable of sustaining, without change, a very elevated temperature.

When oxide of lead is employed, three parts litharge, four parts caustic potash, and forty parts water are boiled together, and as soon as the solution is complete, and has been allowed to cool, forty parts water are added to it; after which it is transferred to a porous vessel, which is placed in water acidulated with one-twentieth part nitric acid. The article to be coated is placed in the porous vessel, and a metallic plate in the dilute nitric acid, the article being connected with the positive, and the plate with the negative pole of a constant battery. In a few minutes the article is covered with a fine dark brown coating of peroxide of lead, which is not in the least disturbed by the burnisher. During the process the litharge is peroxidized by oxygen derived from decomposed water. A coating of oxide of iron is formed by heating protosulphate of iron and ammonia, and using the liquid thus obtained in the same way as the lead solution. It will not answer with articles of copper, on account of the effect produced on that metal by ammonia. The thinner the film of peroxide of iron thus formed, the more adhesive it is; and therefore the process should be continued only until a sufficiently good colour is obtained, which takes place in a few minutes. The iron is peroxidized during the process in the same way as the lead. The article to be covered should in all cases be well cleaned, and be roughened with pumice stone.

Curve produced by a Vibrating String.—A very simple means has been devised for rendering the curve produced by a vibrating string visible. For this purpose the string is illuminated by a bundle of solar rays, reflected by a heliostat. In the path of these rays, a little in front of the string, is placed an opaque disc, presenting transparent diameters at right angles, and capable of revolving on an axis which is at right angles to its plane, so as to make a few revolutions per second. On the other side of the string is fixed a lens of short focus, which forms an enlarged image on a white screen that is placed at the distance of two or three yards. The curve thus obtained will be distinctly visible to the audience of a lecture room.

Self-Registering Electric Thermometer.—A very sensitive and efficient instrument of this kind has been invented by General Morin. It consists of a thermo-electric pile, and a modified multiplier. The thermo-electric pile, which is on the principle of M. Becquerel, consists of thirty rods of iron and maillechort, ranged in parallel grooves, that are formed around a cylinder of wood about two inches in diameter, and have their alternate extremities, which project about three-quarters of an inch beyond the ends of the cylinder, soldered together in pairs. The number of rods that should be employed will depend on the intensity of the current which it is intended to produce when the pile is in operation—that is, when one end is kept at a constant temperature by means of melting ice, and the other end is in the medium, the temperatures of which are to be registered. The multiplier, which the current from the pile is made to traverse, consists of two bobbins, in the centre of which a magnetized needle is suspended by a silk fibre. When in use, the needle should, if no current is passing, lie in the plane of the

magnetic meridian. A wire which is fixed in the centre of the needle, and by the upper extremity of which it is suspended, carries at its lower extremity another needle that is of copper, well balanced, and having at one end a point which projects downwards. This point is intended to mark the deflections of the magnetized needle, produced by the thermo-electric current. For this purpose there is placed under it horizontally an annular disc about two inches in diameter, which carries a disc of paper, and is supported on an upright rod, to which a regular movement of rotation is imparted by clockwork, and which besides, at fixed intervals of a few minutes, is made to ascend and descend vertically by means of a cam. When the disc of paper is raised it comes in contact with the point which projects down from the copper needle, and is pierced by it, since the copper needle is prevented from moving away by an annular disc that is placed over it, and affords a support to it when the paper and point come in contact. The redescent of the paper disengages the point. Thus the deflections of the magnetic needle, and therefore the changes of temperature, are registered, the marks on the paper, if connected by lines, forming a curve. Unless the trepidation which arises from the extreme mobility of the needle are prevented, the registrations can be effected only at certain intervals of time; and in every instance the multiplier must, by means of a case, be protected from currents of air.

New Process for obtaining Oxygen or Chlorine.—This process, which is due to M. Mallet, is founded on the properties possessed by protochloride of copper (Cu_2Cl) of absorbing oxygen from the atmosphere, and becoming oxychloride ($CuCl.\ CuO$), which, when heated to a temperature of 400° C., gives up the oxygen, and again becomes protochloride; the process being capable of repetition, without loss, any number of times with the same protochloride. The latter, to prevent igneous fusion, is mixed with some inert substance, such as sand; and on the large scale the retorts should be capable of rotation, for the purpose, during the separation and reabsorption of oxygen, which may be effected in the same vessel, of equalizing the temperature and keeping the materials well mixed. On the small scale, the process may be carried on in a glass retort, from which the protochloride is removed when oxygen is to be reabsorbed. Reabsorption takes place rapidly with a suitable current of air, especially if the materials are slightly moistened. The same materials and apparatus may be used for obtaining chlorine. For this purpose hydrochloric acid is added to the perchloride after it has absorbed oxygen. The gaseous chlorine disengaged in soda works may be used on the large scale. Bichloride of copper is formed, and chlorine is obtained from this.

Heliochromy on Paper.—The production of pictures in their natural colours has long excited the utmost interest, and will continue to do so until complete success in that direction shall have crowned the efforts of the photographer. What has been already done, though very far from what might be wished, is enough to afford well-grounded hope of the ultimate attainment of so desirable an object. Progress in this department of photography is, no doubt,

slow; but it is something that pictures in their natural colours can now be produced which undergo but little change in a year. Such a result has been obtained by the method of M. Alp. Poitevin, and on paper. He has now made public the methods he uses for the preparation of the paper. A film of ordinary chloride of silver is formed on the surface of photographic paper which has not been albuminized, by bringing one side of each sheet in contact with a solution of chloride of sodium containing ten per cent. of the chloride, and after drying, with a solution of nitrate of silver containing eight per cent. nitrate; or by brushing over one side of the paper uniformly with a mixture consisting of equal volumes of a saturated solution of bichromate of potash, and of a solution of sulphate of copper containing ten per cent. of the sulphate, drying the paper in the dark, applying the prepared surface to the solution of nitrate of silver, removing the excess of nitrate by abundant washing with water, and at the last washing adding, drop by drop, hydrochloric acid until the red chromate is changed into white chloride of silver. To obtain the violet subchloride, a small quantity of a solution of chloride of tin, containing ten per cent. of the chloride, is poured into a dish in which the prepared paper is immersed in water, and without withdrawing the paper from the dish it is then exposed to light in the shade. After about six minutes the required deep violet tint is attained, and the exposure to light must be stopped. The paper is then well washed, and dried in the dark. Its sensibility in this state is very slight, and it may be kept for a considerable time in the dark. The paper thus prepared is best sensitized by means of a mixture of bichromate of potash and sulphate of copper. The fixing agent is water acidulated with sulphuric acid, or, which is preferable, a very dilute solution of bichloride of mercury, similarly acidulated with sulphuric acid. The acidulated water dissolves certain compounds of silver which are formed in spots; and, after the picture has been dried in the dark, it is so little sensitive to light that it will keep very well in an album, and may without injury be looked at with artificial or even diffused light.

Production of Iron from Copper Ore.—Certain ores of copper leave, as residue, after the copper has been extracted, a nearly pure oxide of iron, which would be very valuable, as a source of iron, were it not that its state of minute division renders its reduction by the ordinary methods impossible. It has, however, been found that the difficulty may easily be removed. For this purpose, it is only necessary to agglomerate the oxide into masses of convenient size; which is effected, by drying it, until it contains only about fifteen per cent. water, mixing it with five per cent. hydraulic cement in powder, and sifting the mixture; then moulding the latter by means of any of the machines ordinarily employed for making bricks, considerable pressure being applied, and exposing for some days to the air. The masses thus obtained are sufficiently cohesive for reduction in any of the furnaces used in the iron manufacture. The addition of the hydraulic cement is an advantage, rather than the contrary, since its materials serve as a flux.

Miscellaneous.—*Staining of Wood.*—The aniline dyes are now, with excellent results, applied to the staining of the softer woods, so as to impart to them the appearance of the more valuable. And the process is the more satisfactory, as the wood is coloured throughout its whole substance. To effect this, the air is exhausted from the pores of the wood, after which the aniline dye is injected. ——*Production of Blacks by the Daguerreotype Process.*—The blacks ordinarily produced by the daguerreotype picture are merely negative; that is, they are due simply to the absence of light, which is reflected away from the eye by the polished surface. Some time since it was found that they might be obtained by acting on the sensitized plate with two complementary colours in succession. More recently, M. Niepce de St. Victor has discovered a means of producing them at once, and by a simple process, that consists in plunging the plate, which has been prepared as for the production of the natural colours of objects, into a bath, formed with fifty centilitres of alcoholized soda to one hundred grammes of water, containing a very small amount of common salt; raising the temperature to 60° Cent., and keeping the liquid, which is to be constantly stirred, at that temperature for a few seconds; then taking out the plate, rinsing it well with water, and heating it. The slight reduction of the chloride of silver which has taken place will have given the plate a violet blue tint; and if it is now covered with a varnish consisting of dextrine and chloride of lead, it will afford blacks along with the other colours. There are modes of intensifying the blacks thus obtained, but they are attended with certain inconveniences which render their application not desirable.

LITERARY NOTICES.

Descriptive Astronomy. By George F. Chambers, F.R.A.S., of the Inner Temple, Barrister-at-Law. Oxford, at the Clarendon Press.—A few years ago, Mr. Chambers brought out a book on Astronomy, and the present work, though not so acknowledged in the title page, is a second and enlarged edition of the first one. Any one taking up the book, and led by the title page and preface to regard it as a new one, and discovering on examination that it is simply an improved edition, would consider that he had not been treated in the usual straightforward way, and we cannot but regard it as a mistake in so respectable a firm as that of Messrs. Macmillan and Co., to have permitted Mr. Chambers to give a fallacious aspect to his really useful compilation. Taking the book altogether, it will be found very useful for amateur observational astronomers, as it brings together, in a compact form, a considerable range of information constantly required in private observatories. The plan is, first to describe, in a brief manner, the sun, and the larger planets, then follow chapters on eclipses of various kinds, transits of the inferior planets and occultations. "Physical and Miscellaneous Astronomical Phenomena" occupy several chapters. Comets receive notice

in several more, and the list of "Comets whose orbits have not been computed," published originally in our pages, reappears, without any acknowledgment of its previous issue. "The Starry Heavens" supply themes for eleven chapters, which include a catalogue of variable stars, and some other useful lists. Astronomical instruments, and the mode of adjusting and using them usefully, occupy nine chapters, after which comes a "Sketch of the History of Astronomy," and remarks on meteorites, and the book concludes with a series of astronomical tables. From this sketch of contents, the utility of the work will be apparent, though it is defective in many particulars, and exhibits rather a plodding industry in extracting from other books, than any originality of conception or power of exposition. Its chief merit is that it supplies a gap, and we could not indicate any one volume, extending over the same range of subjects, and compiled with the same regard to the average wants of amateurs.

At page 35, the reader will notice a long passage on the comparative sizes of the sun and planets, and of the orbits of the latter, taken almost *verbatim* from Sir J. Herschel's *Outlines*, without acknowledgment; and the explanation of the harvest moon, at page 80, is copied in the same way, and printed as if it were original. There are many other appropriations without adequate confession. At page 502, nebulæ are spoken of as "probably all stellar," thus ignoring the important discoveries of Mr. Huggins. Mr. Chambers speaks of his not being quite satisfied with the illustrations of nebulæ, etc., and we believe he made the same observation in the first edition of his book. Some are tolerable, and others so bad, that they ought not to have reappeared. In Plate xxiv. is a most preposterous view of the cluster 47 Toucani, stated to be "drawn by Sir J. Herschel." This cluster is figured in the *Cape Observations* of the distinguished astronomer, whose name is thus made use of, but his figure, in its main features, bears *no resemblance* to the remarkable object which Mr. Chambers supplies. We feel it is right to make great allowances for popular works that endeavour to figure delicate clusters and nebulæ, as they are extremely difficult to engrave satisfactorily, but no artist and no compiler can be justified in issuing, on the authority of a great observer, such a pure invention and fiction as the plate we complain of.

ANNUAL REPORT OF THE BOARD OF REGENTS OF THE SMITHSONIAN INSTITUTION, showing the Operations, Expenditures, and Condition of the Institution for the year 1865. WASHINGTON, 1866.—In a former number we gave an account of the "Smithsonian Institution," and of the valuable character of its labours. The present report shows that much good work was done in the period to which it refers. The publications embrace *A Description of Magnetic Observations made at Girard College; Palæontology of the Upper Missouri; Cretaceous Reptiles of the United States; Astronomical, Magnetic, and Meteorological Observations within the Arctic Circle;* an *Investigation into the Orbit of Neptune.* These are quartos, and the octavo series comprises a *Review of American Birds in the Smithsonian Collection; Researches upon the Hydrobriinæ;* a continuation of the *Synopsis of American Land and Fresh-water Shells, etc.* From the Secretaries'

Report we learn that the Polar Observations indicate a smaller value than had been hitherto assigned to the polar flattening of the earth. "The compression, as deduced from Mr. Schott, from all the observations of the expedition under Dr. Hayes, is one 377th part of the polar radius. The excess of the number of vibrations in a day at Port Foulke, over the number made by the same pendulum in the same time in the Harvard Observatory, was $129\frac{1}{2}$." Further experiments with the same pendulum are in progress, to ascertain the number of its vibrations at various points of the meridian on which Port Foulke lies, in order to obtain a series of independent observations of the curvature of the earth. Curious information as to the climate of the polar regions seems to have been obtained; thus, Port Foulke, which is in the vicinity of open polar water, showed 26° higher temperature than Van Rennselaer Harbour, only 53 miles distant from it. The maximum difference was $46\frac{1}{2}$ on the 20th March, 1861. The warmest day was on the 15th July, when the temperature was 41°·6 F., and 16th Feb. was the coldest, being —28° F. The N.E. winds coming over Greenland were found to be the coldest, and the S.W. the warmest, but "the effect of the various winds on the whole is small, not exceeding an elevation or depression of more than $1\frac{1}{2}$° from the mean. The most intense cold was experienced during calms. Snow and rain exert much more influence on the winter temperature than wind; on an average, in winter, during every fall of snow, the temperature was elevated 8°·6 F., and in summer fell $1\frac{1}{2}$° during a fall of snow or rain." Clear days in winter were on the average the coldest by $3\frac{1}{2}$°, and the highest in summer by 0°·8. The quantity of the stream of air passing in the course of a year over the field of observation was nearly 60,000 miles.

The *Smithsonian Report* for 1865 has the usual appendix, in the shape of a series of useful papers selected from various sources, and is well adapted to diffusing scientific knowledge.

Modern Arithmetic; a Treatise adapted for the School and for Private Study, containing numerous improvements in aid of the Preparation of Candidates for Public Examinations. By the Rev. John Hunter, M.A., formerly Vice-Principal of the National Society's Training College, Battersea. (Longmans.)

An Easy Introduction to the higher Treatises on Conic Sections. By the Rev. John Hunter, M.A. (Longmans.)

These publications of Mr. Hunter evince a clear perception of the difficulties of students. The arithmetic, especially, is very superior to most of the works in general use.

The Twin Records of Creation, or Geology and Genesis, their perfect harmony and wonderful concord. By Geo. Victor le Vaux. (Lockwood.)—This is one of those unfortunate publications which will be liked best by those who are in the most complete accordance with the writer's theology, and who possess the least knowledge of geological investigation.

A Monograph of the British Fossil Crustacea, belonging to the Order Merostomata. Part I. Pterygotus Anglicus, Agassiz. Pages 1—44. Plates i.—ix. By Henry Woodward, F.G.S., F.Z.S., of the

British Museum. (London: printed for the Palæontographical Society, 1866.)—Mr. Woodward unites the Eurypterida and Xiphosura under the order Merostomata, proposed by Dana for king crabs only. The term "Merostomata" is derived from μηρος, a thigh, and στόμα, a mouth; the peculiarity of the order being that the creatures it includes "have a mouth, furnished with mandibles and maxillæ, the terminations of which become swimming feet and organs of prehension." The present part of Mr. Woodward's work commences with some important introductory observations, and then describes the *Pterygotus Anglicus*, with the help of numerous figures of fossils, and of recent crustacea, for comparison with the former. Our readers will recollect an important paper by Mr. Woodward in our vol. iv., p. 229, accompanied by a fine plate. To this paper we may refer for highly-interesting information on a very curious group of animals. The present monograph will evidently take a high rank amongst similar publications, and it is illustrated by numerous well-executed plates.

The Student's Text-book of Electricity. By Henry M. Noad, Ph.D., F.R.S., F.C.S., Lecturer on Chemistry at St. George's Hospital, author of a "Manual of Chemical Analysis," "A Manual of Electricity," etc. With Four Hundred Illustrations. (Lockwood and Co.)—Since the publication of Dr. Noad's *Manual of Electricity* we have constantly used it as a book of reference, and found its merits of a high order. The present volume is founded upon it. An admirable method of compression is employed, and the type, though smaller than that of the Manual, is very clear. The various subjects are all brought up to date, and, as a student's book, none that we are acquainted with can compete with it.

The Art of Wood Engraving: a Practical Handbook. By Thomas Gilks. With numerous Illustrations by the Author. (Winsor and Newton.)—Mr. Gilks enjoys an excellent reputation as a wood-engraver, and the present pretty little volume explains step by step the various processes by which a wood engraving is made. The lessons are well selected and simply explained, and cannot fail to prove useful to those who wish to practise an elegant art, and to be acquainted with the principles on which it is conducted.

A Description of the New Telescopes with Silvered Glass Specula; and Instructions for Adjusting them. By John Browning, F.R.S. (Straker and Sons.)—The great importance of the new telescopes gives value to this pamphlet in explanation of their peculiarities. Mr. Browning certainly does not overrate their merits. One which we have, and others which we have seen, deserve more praise than his modesty has assigned to them. This pamphlet contains a great deal of valuable matter.

Hints on Spectacles: When to Wear, and how to Select them. By W. Ackland, Surgeon. (Horne and Thornthwaite.)—The primary object of this pamphlet is no doubt to sell the spectacles made by Messrs. Horne and Thornthwaite, in connection with whose establishment Mr. Ackland is well and honourably known to the scientific world; but it differs, like Mr. Browning's pamphlet, from an ordinary trade puff. It contains a well written exposition of the

optical principles of *the eye*, and of the instruments by which its vision may be assisted, and thus having a scientific value, it comes within our rule of publications that we can notice and commend. It is not for us to say, out of a multitude of other respectable opticians, which is the best house for spectacles, but we strongly recommend our readers to avoid cheating quacks, and to make their purchases of reliable firms.

Geology for General Readers. A series of Popular Sketches of Geology and Palæontology. By David Page, F.R.S.E., F.G.S. Second and enlarged Edition. (Blackwood and Sons.)—Mr. David Page is one of the most successful epitomizers and popularizers of science, and in this capacity he merits no small commendation. The present edition of a well-known work evinces his usual skill and care. It belongs to a class of book gradually finding its way into all the better kind of schools, and is well suited for family reading.

The Birds of Norfolk, with Remarks on their Habits, Migration, and Local Distribution. By Henry Stevenson, F.L.S., Member of the British Ornithologists' Union. In two vols., vol. i. (Van Voorst, Norwich, Malabret & Stevenson.)—The present volume is an excellent specimen of a very valuable class of works, which, under the form of contributions to local fauna, not only answer the purpose of a useful catalogue, but contribute efficiently to the science of Natural History. An accurate list of species inhabiting or visiting any district is in itself an important contribution to knowledge, but much more so when, as in the case of Mr. Stevenson's book, it is accompanied with a large amount of interesting information concerning the habits, food, structure, etc., of the creatures described. Although Norfolk is by no means one of the most beautiful of English counties, its position and physical characteristics assign to it a very high degree of ornithological importance. "Bounded on the north and east by the German Ocean and the great estuary of the Wash, Norfolk is insulated, as it were, in every other direction by rivers, the Waveney and Little Ouse dividing it from Suffolk on the south, and the Great Ouse, Welney, and Nene from Cambridgeshire, on the west." It is favourably situated, as Mr. Stevenson observes, with reference to Holland, the west coast of Norway, and the north-east coast of our own island. Its coast line makes it a convenient place of "call," and thus it is that "a classified list of the birds of Norfolk shows an excess of imigrants over residents, amounting to nearly two-thirds, while the latter are even outnumbered by rare and accidental visitants." The local peculiarities of the county are likewise favourable to ornithological variety. The "Broad district" is full of shallow lakes and lagoons, locally termed "Broads." The "Cliff district" is sandy, and contains an admixture of arable land, pastures, woodland, and heath. The "Weal district," so called from the sandy hillocks or "weals" lying between the sea-shore and the cultivated land, with flat oozy plains between them. The "Break district" has a light thin soil lying on chalk, partly broken up by the plough, and many of these "breaks," or broken up places, abandoned to wild birds and game. "The effect of high winds after dry weather in this district," says

Mr. Stevenson, "is not easily described. The whole air is filled with sand, till it resembles a London fog. Nearly every particle of fertilizing matter is blown away from the land, as is shown for years afterwards by its barrenness." Then there is the "Fen district," and the "Enclosed district," names sufficiently significant of their character, if allowance is made for the progress of cultivation.

The detailed account which Mr. Stevenson gives of these districts is very interesting, and they afford appropriate conditions for the habitation or sojourn of many rare birds. The descriptions given by Mr. Stevenson of the decline or disappearance of particular birds, as artificial changes have been introduced in the physical features of the locality, are very important, and not less so that of the settlement and multiplication of other species for whom the new conditions operated favourably. Thus within thirty or forty years, three species of harriers have disappeared from the fens, in consequence of their drainage by machinery. Ruffs and reeves have likewise vanished, "but the red-shank was induced to return to its old haunts by the extraordinary flood of 1852. . . . This same flood acted in like manner upon the black tern and the black-headed gull, both of which, in 1853, stayed to breed in places which had been so long abandoned by them, that their names were even unknown in the land."

The present volume begins with the white-tailed eagle and ends with the quail, and includes descriptions of the visits and habits of many rare birds, waxwings, crossbills, etc, and of Pallas' sand-grouse, of which a beautiful coloured plate is given. Our readers will recollect a paper on the curious fact of the appearance of this bird in England, which we published in our fourth volume.

In the chapter devoted to the kingfisher, Mr. Stevenson utters a protest against the destruction of these birds to furnish ornaments for ladies' hats; and it is really abominable, that one of the most interesting British birds should be in danger of absolute extirpation in obedience to a mere whim of fashion, and to an unfortunate over development of the monkey habit of imitation. He also records a visit to a kingfisher's nest. It was placed in a hole like that of a rat in a "dyke," or drain, about a foot below the top of the bank, and the same distance from the water. The hole sloped gradually upwards from its mouth, and terminated in a round chamber, "filled with the remains of fish in every stage of decomposition. There were seven eggs laid exactly in the centre on a bed of pure white fish bones, and surrounded with fish refuse swarming with maggots. The fish bones when cleaned weighed ten ounces and thirty grains, and must have represented a great quantity of the small fry which form the chief part of the kingfisher's food. Mr. Stevenson noticed remains of water-beetles, but not a particle of grass, straw, or similar material.

Strongly recommending his work, as both interesting and valuable, and further mentioning that the frontispiece to the first volume represents one of the "Norfolk Broads," we leave it with the intention of completing our notice when the second volume appears.

CORRESPONDENCE.

THE following letter is from the Rev. J. D. La Touche:—

"SHADOWS DURING THE SOLAR ECLIPSE.

"It has often been remarked that the light during an eclipse of the sun is of a very peculiar character, differing not only from the diffused light of a hazy day, but from that of a less luminous body, such as the moon. This arises, I believe, to a great extent, from the peculiar nature of the shadows thrown by all objects in consequence of the great change which has taken place in the shape of the surface from which the light proceeds.

"My attention was attracted to this during the late eclipse, when, in order to give a large party of school-children simultaneously a view of the wonderful sight, without the aid of smoked glass, I made a few small holes in a piece of card, and holding this at some distance from a sheet of white paper, just as many beautiful crescents appeared, exhibiting to my much-pleased audience, the progress of the eclipse.

"In making this experiment, however, it was soon manifest that not only the image of the sun, transmitted through the little holes in the card, was changed from the ordinary circle (to which, by the way, we are so accustomed, that I dare say many, when they behold it, are not aware that it is really an image of the sun itself), but it appeared that the edges of the shadow of the card had also undergone an equally remarkable change.

"Every one must have observed, that around the edges of every shadow cast by the sun, is a gradually softened-off margin or penumbra, which, when the object casting it is at six feet distance from that on which it falls, extends, under ordinary circumstances, for about nine-sixteenths of an inch equally round it on every side. This is caused by the sun being, not a luminous *point*, but a disc of considerable size, every portion of which gives off rays of light. Where, as in the case of the electric light, the luminous body is a mere point, all shadows will be sharp and distinct—even those of hairs will be defined with a clearness which strikes most spectators with surprise; but where the diameter of the luminous surface is considerable, a certain breadth of half-shadow is produced, exactly corresponding to the angle which the disc subtends, and the distance of the opaque body which casts the shadow from the screen on which it is received, and this penumbra will necessarily be modified by the shape of the luminous disc as well. Thus, when the sun is undergoing eclipse, its crescent form will alter the shape of every shadow it gives rise to. In our direction, the diameter of its disc remains unaltered, while in the other it is greatly diminished, causing a corresponding change in the marginal shadow of every object.

"Now, in the late eclipse, at the time of greatest obscuration, the crescent was in a somewhat horizontal position, and accordingly, though all vertical shadows remained of the same width as before, horizontal ones were greatly diminished, and this was very striking in our experiment. When the piece of card, moreover, was caused to turn round in its own plane, a regular proportional change took

place in the shadows of each edge, each diminishing as it approached a position parallel to the line of the curves of the sun's crescent, and increasing as it became perpendicular to it. There was, moreover, observable a peculiar curving upwards of the line of junction of the penumbras of the horizontal and vertical edges of the card at the angles of the shadow, which evidently corresponded to the crescent shape of the sun itself.

"Of course, the shadows of all other objects were at the same time thrown out of proportion. Thus, when the hand was held horizontally and edgeways in front of, and at some distance from, the sheet of paper, its shadow above and below was very much more sharply defined and narrow than under ordinary circumstances, but if it was held vertically, the indistinct penumbra took the place of any distinct shadow.

"These effects were very remarkable, in consequence of the beautiful clearness of the sky here at the time of the eclipse, and suggested the thought, that this considerable modification of other shadows could not but affect the usual aspect of all the objects around, and contribute to the peculiarity of their appearance."

PROCEEDINGS OF LEARNED SOCIETIES.

GEOLOGICAL SOCIETY.—*Feb.* 20.

Warington W. Smyth, Esq., M.A., F.R.S., President, in the Chair.

The following communication was read:—

On the British Fossil Oxen.—Part II. *Bos longifrons*, Owen. By W. Boyd Dawkins, Esq., M.A. (Oxon.), F.G.S.

The author analyzed the characteristics usually assigned to *Bos longifrons*, and concluded that there were none of specific value to separate it from the smaller varieties of *Bos Taurus*. The large series of skulls in the Dublin and Oxford Museums show that *Bos frontosus* of Nilsson is a mere variation from the more usual type. Professor Owen, on the faith of its occurrence on the Essex shore, along with the remains of extinct animals also washed up by the waves, ascribes to this species a Pleistocene age. This inference, on a rigid examination of the premises, turns out to be faulty, and there is no evidence anywhere in Europe that it co-existed with any of the extinct mammals, the Irish elk being excepted. It is very commonly associated with the remains of man, of a date anterior to the Saxon invasion. It was kept in great herds during the Roman occupation, and supplied the legionaries with beef. On the Continent, as in Britain, it is found around the dwellings and in the tombs of the Bronze and Stone folk. Nowhere is there evidence of its having a higher antiquity than the Neolithic age of Sir John Lubbock. It disappeared along with its Keltic masters before the Saxon invaders from the more fertile portions of Britain, and took refuge in the highlands of Scotland and Wales, where it still

survives in the smaller domestic races. In no case has it been found in association with Saxon remains. The inferences to be drawn about it are, first, that it has not yet been *proved* to have existed before the pre-historic age; and, second, that it is the ancestor of the small Highland and Welsh breeds. It is essentially the animal with which the archæologists have to deal, and its only claim for insertion in geological catalogues is the fact of its occurrence in the most modern of all the stratified deposits.

ROYAL MICROSCOPICAL SOCIETY.—*March* 13.

James Glaisher, Esq., F.R.S., in the Chair.

A paper was read by Dr. McIntosh describing gregariniferous parasites found in Borlasia. Mr. Jabez Hogg alluded to the absurd stories in the *Times* and other papers concerning the gregarinæ in the chignons. He stated that empty egg-shells of the louse had been discovered on dirty specimens, and in some other cases a fungoid growth that is associated with ringworm.

Mr. Whitney read a highly valuable and instructive paper on the development of the breathing organs of the tadpole, which he illustrated by a series of large and beautifully-executed diagrams. He showed how the internal gills grew, and caused the atrophy of the external ones by interrupting their blood supply. The internal gills could be seen by stupefying the tadpole by means of a drop of chloroform, and then dexterously cutting away the integument. When fully developed they exhibited beautifully ramified tufts, with efferent and afferent vessels. The true lungs were quite distinct from these internal gills, and were developed at a later period.

It was announced that the annual soireé of the Society would take place at King's College, on the 24th of April.

NOTES AND MEMORANDA.

Polyps of the Hyalonema.—At an excellent soirée recently given by the Old Change Microscopical Society, Mr. Tyler exhibited specimens of the polyp cells attached to the glass rope of the Hyalonema sponge, with the zoanthoid polyps *in situ*. His preparations seem quite decisive in favour of the views of Brandt and Schulze, supported in our pages by Professor Wyville Thomson, and conclusive against the opinion of Dr. Bowerbank, that the supposed polyp cells were excretory orifices of the sponge. In the *Annals of Natural History* for March, Max. Schultze has a paper to vindicate his views of the Hyalonema, in which most naturalists coincide. He speaks of the close resemblance in structure between the long spicules and the shorter ones forming the body of the sponge. With reference to the polyps (*palythoa*), he states that Oscar Schmidt has found a similar polyp parasitic upon a sponge in the Adriatic. He also alludes to the way in which the polyps themselves with their thread capsules may be made visible, as in Mr. Tyler's preparations.

Photographing the Moon.—The Lunar Committee of the British Association have issued a series of tables prepared by the Secretary, Mr. Birt, to show the most favourable periods for photographing, or drawing particular parts. Observers

who can assist the Moon Committee should obtain a set of their tables by communicating with W. T. Birt, Esq., 42, Sewardstone Road West, Victoria Park, London, N.E.

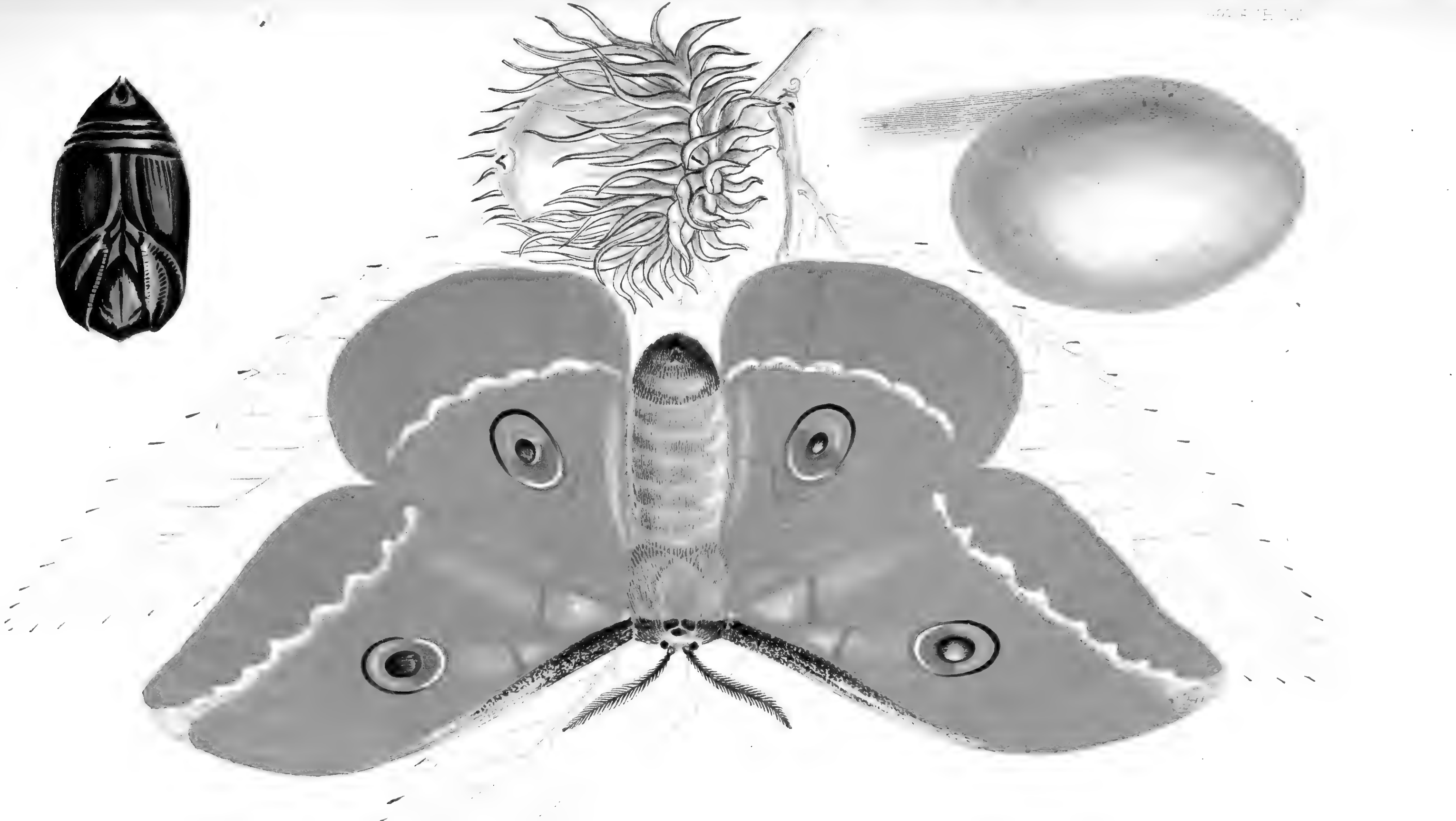
Experiments on Cell Formations.—The *Proceedings of the Royal Society*, vol. xv., No. 88, contains an important paper by Dr. Montgomery on cells. He shows that so-called "organic" cells of cancer and other tumours expand on the addition of water to several times their original size, and at last vanish in the surrounding medium. The nucleus did not always participate in this change. Artificial processes were then adopted, and it was found that when myeline, in its dry amorphous state, was placed in water, slender tubes shot forth from the free margins, "wonderfully like nerve-tubes." When intimately mixed with white of egg the myeline formed "instead of tubes, splendid clear globules, layer after layer, resembling closely those of the crystalline lens formed under similar conditions." "By mixing myeline with blood serum, globules were obtained showing the most lively molecular motion. When the serum somewhat preponderated, the whole globules seemed, after a while, to undergo coagulation, and appeared often as beautifully and finely granulated as any real cell. When this mixture of myeline and serum was spread very thinly over the glass slide, there often started into existence, with the addition of water, small primary globules, round which an irregular mass of granular material became gradually detached from the glass slide. It at last shaped itself into a secondary globule, enclosing the primary one, and constituting with it, down to the minutest details, the most perfect typical cell." . . . "If the amorphous myeline be very thinly spread on a glass slide instead of tubes, there will form bodies looking like rings. They are actually double globules, the inner globule being more transparent than the outer." When dried, and afterwards wetted, the inner globule becomes the nucleus. If serum is added instead of water, biconcave discs are formed like blood corpuscles, but larger.

The Mammoth in the Bay of Tas.—The expectations of finding a complete mammoth in this situation have been disappointed. M. Schmidt, on arriving at the locality, found the remains in an imperfect state. He has brought away hair, skin, and bones, but the internal organs had perished, and he could obtain no positive information as to the nature of the creature's food.

Silurian Life.—The *Proceedings of the Royal Society*, No. 90, contains an account by Dr. Bigsby of a work on Silurian Fossils, which he proposes to call *Thesaurus Siluricus.* He says it "contains 7,553 species, and probably it does not give the tithe of the whole Silurian life yet lying buried under the wilds of the arctic circle, of Hudson's Bay, Labrador, the two Americas, Scandinavia, Australia, India, etc., etc. It appears that the number of species known in 1856 was only 1,995. "In the primordial group," says Dr. Bigsby, "we find numerous representatives of nearly every marine invertebrate, and we have a startling example of the sudden development in very early times of the highest types of molluscan life, nautili, litpites, trilobites, protichnites, etc."

Action of Quinine on the Nerves.—M. Eulenberg states in *Comtes Rendus*, that injecting three to twelve centigrammes of sulphate of quinine under the skin of frogs arrests respiratory movements and the action of the heart. He considers it to operate first on the central foci of reflex action in the spinal chord, and afterwards on the cerebral foci of sensation and movement.

The Solar Eclipse, March 6.—At Madrid, Dr. Aguilor, of the Observatory, was able to make thermometrical observations under favourable conditions of clear sky. He used two of Casella's thermometers, placed out of the direct rays of the sun. Their coincidence all through was very close. March 5, 19h. 50m. they both showed 21°·5. The eclipse was at its maximum at 20h. 54m., and 20h. 55m. the temperature was 7°·8 according to one instrument, and 7°·9 according to the other. The lowest was at 21h., 7°·5 and 7°·6. At 22h. 20m. one showed 26°·8, and the other 26°·5.



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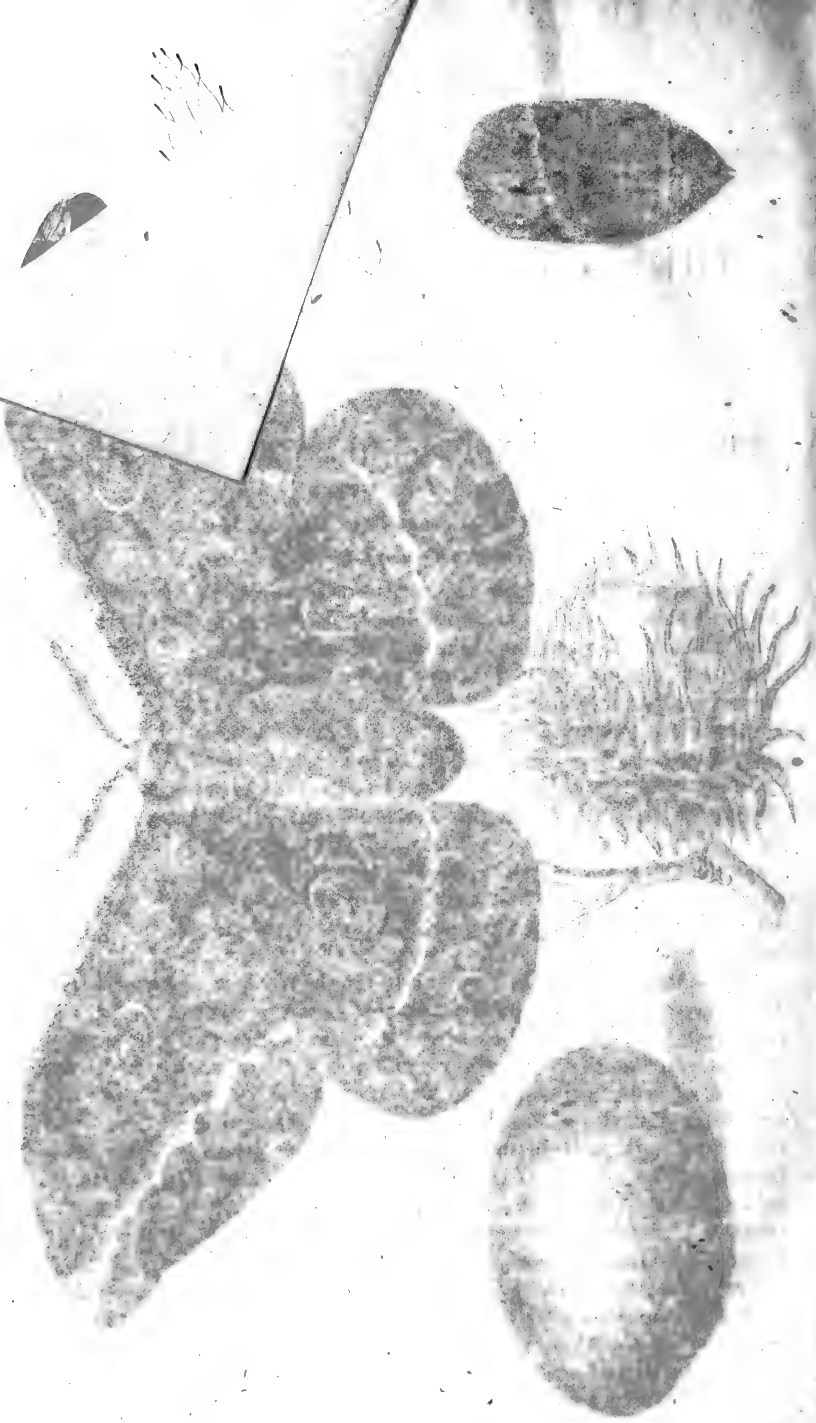

THE INTELLECTUAL OBSERVER.

MAY, 1867.

THE NEW OAK-FEEDING SILKWORM OF CHINA.

BY JOHN R. JACKSON,

Curator of the Museum, Royal Gardens, Kew.

(*With a Coloured Plate.*)

In years gone by, when the present generation of men were boys at school, almost the first lesson learnt in Natural History was the rearing and cultivation of silkworms. If our self-imposed lessons in sericulture were calculated to implant a taste in this direction for development on a larger scale in after life, what a nation of silk cultivators we should by this time have been. We, as boys, used to look upon the little creatures so busy enclosing themselves in their silken houses, and think it almost past belief that our mothers' and sisters' dresses could be composed of so many of those silky cocoons. Since the days of which we speak a great revolution has taken place in the culture of silkworms, and boys in these days could scarcely be expected to keep themselves posted up in all the newly introduced insects.

The disease which has made such ravages amongst the *Bombyx mori*, or common mulberry-feeding silkworm, in the South of Europe, has been the means of directing attention to new sources for a supply, or at least for aids to the ordinary supply of silk. This, like the cotton, the paper, and the cinchona questions, has become one of great importance. In the great silk cultivating districts in the South of Europe a failure in the supply of this article would, to those populations, be as keenly felt as the cotton famine was to our own operatives a few years since, besides seriously affecting one of our home industrial classes, the silk weavers. Science has also gained something, and will probably gain more, from the experiments in the acclimatization of these insects, as in the case of the *Bombyx Cynthia*, or ailanthus worm, which is proved not only to exist, but even to be more healthy and vigorous in this country than in France. It is now about ten years since the *Bombyx Cynthia* was first reared in Europe, and since then

many others from India, China, Japan, and Australia have been brought into notice.

The latest of these is the oak-feeding insect of China, the *Antheræa Pernyi*, Guer. Menne. It produces what is known as mountain silk, which has of late become a most important article of trade amongst the Chinese. A description of this insect, and of the oaks upon which it feeds, will probably be of some interest to the readers of the INTELLECTUAL OBSERVER. Specimens of the foliage and the acorns of these plants, together with some cocoons containing chrysalids, and some hanks of the silk, were recently received at Kew from China, and from these materials the species of Quercus have been decided. Two of them, called by the Chinese respectively large and small "Tsing-kang-lew," appear to be *Quercus Mongolica*. Another called "Hoo-pŏ-lŏ," is *Quercus obovata*, Bunge, the leaves of which are larger and darker in colour than those of *Quercus Mongolica*. There is also a marked difference in the acorns, which are larger, and the scales long and tapering, and of a dark brown colour, thus giving to the cup the appearance of being covered with long brown fur, which also partly covers the acorn itself. The fourth is called "Tseen-tso-tsze," and is the *Quercus serrata* of Thunberg. The silkworms fed upon this oak produce the best silk; the tree, however, is not so common in the silk districts as either of the other species.

The next best quality of silk is produced by feeding the insects upon the leaves of *Quercus Mongolica*, those of *Quercus obovata* producing the most inferior description. Two crops of silk are produced by the *Antheræa Pernyi* in one year—a spring and an autumn crop. The cocoons, which are very large, as will be seen by the Plate, are carefully selected by the silk growers after the autumn crop of silk has been collected, and stored away in baskets, which are usually hung up in ordinary living rooms for the spring. The ordinary heat of a Chinese living room during the winter seems to be quite sufficient to prevent the frost affecting the chrysalids. The temperature of a Chinese dwelling in the mountain silk districts is during the greater part of the winter considerably below freezing point. It is thought that the chrysalis would not be affected even if exposed on the trees during an ordinary winter night in the Chinese forests, and if this be so, it will probably prove hardy enough to bear our climate. Towards the end of April the oaks upon which the caterpillars feed begin to open their young leaves, and to push forward the growth of these leaves so as to have food in readiness for the caterpillars when hatched; twigs are cut off the trees, and placed either in tubs of water in dwelling-houses, or in pools and mountain streams. By the time the leaves have expanded, the moths have made their

escape from the cocoons, have paired, deposited their eggs, which are hatched on sheets of paper upon which the young leaves of the oak are placed. The insects are thus nursed and nourished for a few days, by which time they have grown to about an inch in length. They are then transferred to the trees themselves on the hill slopes, the younger and the most tender-leaved plants being selected. Some days elapse before the caterpillar moults for the first time; it also changes its colour from black to green, and increases considerably in size. It goes through four of these changes, after each of which its bulk is increased, but it retains its green colour. It now begins spinning its silk, and of course encloses itself in its cocoon, there again to take the chrysalis form. These natural changes are gone through much quicker in the spring than in the autumn season, a difference of five or six weeks existing. In each season, as fast as the caterpillars consume the leaves of one oak bush they are removed by the attendant silk cultivator to another, the youngest bushes being first used.

Mr. Meadows, the English Consul at Newchang, says, "I was in some of the silk valleys from the 29th of August to the 12th of September, and had an opportunity of observing the autumnal worms in their last stages. The most advanced began weaving their cocoons around them on the 2nd of September, but at this time a large proportion of the worms were still in the stage between the third and fourth sleeps, while others, which had cast their skins for the last time, were feeding hard in preparation of the work of cocoon spinning. On the 12th of September fully one half were enclosed in, or busy with, their cocoons, while the most backward had all changed their skins for the fourth time."

As the description of the insect, as given by Mr. Meadows, may be better understood by many of our readers than a purely technical one, we will quote it entire:—"Just before spinning its cocoon, it is a bright green-bodied grub or caterpillar of about 3½ to 4 inches in length, with a light brown head. On its pale brown face there are six or eight small black specks. Its body has twelve joints. On eight of these, it has on each a pair of claws, five pairs of what I shall call back claws on the hinder part of the body, and three pairs of front claws on the forward part. The hindermost, or tail joint, has a pair of the back claws; then there are two joints without claws; then come four joints, each with a pair of the back claws (one on each side); then come two joints without claws; and then the three foremost joints, each with a pair of the front claws. The five pairs of back claws are less developed as claws than the front ones, being, to outward appearance, of the same soft green matter that the body is composed of; and merely tipped

with a small piece of hard substance of the same light brown colour as the head. The three pairs of front claws are, on the other hand, curved; and are entirely composed of the hard, light brown substance. The five pairs of back claws serve as feet, by means of which the animal holds on to the twig, or stem part of the leaf, while the front claws serve as hands, by means of which it twists round the edge of the leaf to its mouth. When the grub is in one of its torpid periods, it holds on to the twig solely by means of the five pairs of back claws, the foremost five joints (three with claws and two without) being altogether detached from the twig, in the air. A little above the claws on each side there is, on each joint or segment, a bright blue speck, out of which two or three hairs grow. A little above these blue specks there is on each side, down the last or tailmost, nine joints, a brownish streak, which two streaks widen and join together as a brown band on the tail joint. On the eighth and ninth of the joints, counting from the tail end, there are on this brown streak two silvery or white metallic coloured spots on each side. The brown band does not extend to the foremost three joints; on the other hand, each of these joints has two blue specks on each side, one above or higher up than the other. The animal is thickest about the second and third joints, counting from the head, and tapers off somewhat towards the tail."

"When the worm begins to make its cocoon, it selects two or more oak-leaves, more or less facing each other, and lower than the twig from which they proceed. These leaves it joins together by a network of its silk thread, which thread keeps issuing from its mouth as it moves its head from one leaf to the other. It holds on, in the meantime, by its back claws to the twig. When the leaves are sufficiently joined to form a sort of cup or basket under the twig to which it is holding, it loosens its hold, and drops into the receptacle it has thus formed. The hindermost seven joints of the body are then with the tail joints slightly curled in, drawn together, and, remaining in a state of total inaction, serve, I presume, merely as a store from which the silk thread matter is drawn. The work of further self-inclosure the animal does with his head, and the foremost five joints of the body. It first quite surrounds itself with the loose flossy-like silk which forms the outer portion of the cocoons as they come to market, and through which its green body remains for a time visible. It then gradually forms the dense, hardish, skin-like substance which constitutes the inner portion of the cocoon.

On opening a cocoon which had been recently formed, and was to outward appearance quite finished, I found inside a complete green worm curled up in the way I have described as

to its hind part, and with the fore part in the condition in which it is when the animal is in one of its sleeps on the bush. After a while the fore part began to move, and the animal to spin silk, which it attached at each turn of its head to the surface of a table on which I had placed it. It seemed to be labouring to increase the thickness of its cocoon, being, doubtless, roused to the necessity of so doing by the feel of the open air to which it was again exposed. I judged that if the cocoon had not been opened, the animal would, after a sleep in it, have proceeded to thicken the inner surface by further thread spinning, and have gone on so doing till its bulk was sufficiently decreased for its turning into the chrysalis shape."

From the foregoing description of the *Antheræa Pernyi*, it will be seen how close it agrees in habit with the *Bombyx Cynthia*, or ailanthus feeder. It remains yet to be proved whether the insect can be successfully reared in this country, and whether it will feed on the leaves of any of our British oaks. If so, and it succeeds in our climate as well as the ailanthus worm, it will prove a valuable companion to that useful insect. The silk appears very strong, and when properly cleaned will, no doubt, prove tolerably bright and flossy. As an article of export from China, it will probably prove a valuable addition to our trade with that country, and if acclimatized with us, would of course be valuable to our home productions.

It appears that these insects are not only useful as silk producers in their native country, but the insides of their huge bodies are drawn out by the Chinese, who make fishing-lines of them, which are of a somewhat similar nature to catgut. We are told by a celebrated traveller in China that these can be sometimes drawn out to a continuous length of fifteen or twenty yards.

The drawing, by Mr. Fitch, is made from a moth which escaped from a cocoon about the middle of February last. This cocoon was kept, amongst others in the possession of the writer, in an ordinary sitting-room, and up to the present time none of the others have made their appearance.

The Plate represents—1. The Cocoon, nat. size; 2. Chrysalis, nat. size; 3. Moth, nat. size. The leaves and acorn are those of *Quercus serrata*, Thb., which produce the best kind of silk.

AN EIGHT DAYS' RAMBLE IN CAPE COLONY.

BY GEORGE E. BULGER,

Captain 10th Regiment.

"SUPPOSE we ask for a week's leave, and take a trip to the Paarl?" said Hendrick to me one morning at the end of July, as we sat at breakfast together in the mess-room at Cape Town. "There ought to be some fine mountains in that direction, and we might also get some shooting." "By Jove, it is a good idea," I answered; "a few days of wandering about would be very pleasant, besides the opportunity of seeing a part of the country new to us."

The leave of absence was easily obtained, and at eleven o'clock the next morning we were travelling towards our destination by the Cape Town and Wellington Railway. We were the sole occupants of the carriage, and, indeed, almost the only passengers in the train; for the traffic on this line is very small, and we heard that it does little more than pay expenses.

For more than four years we had not seen a railway carriage; and the sensation of being once more whirled along by the iron horse was to me quite delightful, after the various uncomfortable modes of travelling with which I had become familiar on the comparatively uncivilized frontier, where it had been our destiny to be quartered since March, 1860.

The morning was very fine, and although it was rather early in the season for us to see the full beauty of the country, yet even the monotonous-looking Cape Flats, between Cape Town and Stellenbosche, a distance of thirty-one miles, were to a certain extent attractive, from the bright flowers which were everywhere coming into bloom amongst the thin and scattered bushes that studded the wide, arid-looking expanse of glittering white sand. Near Stellenbosche the mountains commence, and thence to the Paarl they form the main features of the scenery. Those close to the former place—the Klapmuts range, I believe—are exceedingly bold and grand; they are apparently of great height and utterly barren; indeed, seemingly naked rocks, of imposing form and majesty. Next them comes a more lengthy tier, which, I understand, are the Drakenstein or Dragon's Stone Hills. They, too, are treeless masses of solemn-looking rock, trending away to the northward, and walling-in the valley of the Great Berg River on the eastern side.

The Paarl is eighteen miles from Stellenbosche, and we arrived there shortly after one o'clock. The railway station is

fully two miles from the town, but we found carts in waiting for new-comers, one of which soon carried us and our belongings to the exceedingly pleasant little hotel kept by Mr. Schmidt, a stout, jolly-looking Dutchman, whose kindness and attention to our wants during the few days we spent under his hospitable roof will long be remembered by Hendrick and myself. The drive from the station to the hotel was very pleasant; the country was fresh and bright looking; and the noble pine-trees and oaks, which lined some portions of the road, elicited our warm admiration.

We spent the remainder of the day in rambling about the Paarl—which, being translated into English, means Pearl—and examining the general features of the valley. The village, or town, is one long street, which stretches in a direction parallel to the course of the Great Berg River for several miles; the people told us eight, but I should say it is a good deal under that distance. The houses are all built in the Dutch style, and, almost without an exception, are shaded with pine-trees, which add vastly to the beauty and picturesque appearance of the place. The trees, moreover, are by no means entirely of an indigenous character, for those of many dissimilar countries and climates are found here growing happily together, and thriving in the genial atmosphere of this lovely valley. Lofty pines, whose deep green foliage is suggestive of more northern regions, contrast gracefully with the delicate acacia-like branches of the Pride of India; majestic oaks of high antiquity stand side by side with the Blue Gums of South Australia, and the scarlet-flowering pomegranates, said to have been first brought from Carthage; here are mulberry-trees of immense size; there the soft English-looking woody poplar, loquats, almonds, peach-trees, opuntias, huge stately agaves, luxuriant orange-trees, laden with golden fruit and redolent of rich perfume; camellias, with their peerless blossoms; scarlet aloes; and whole hedges of roses;—all blend harmoniously into one lovely and smiling picture. Vineyards are attached to almost every house, for the Paarl is in the heart of one of the finest wine districts of the country; but at the time of our visit the plants were all brown and leafless, so that they added little to the beauty of the scene around them.

The Great Berg River, a considerable stream, flows through the valley a little below the town, and eventually after a winding course of about a hundred miles from its source in the Fransche Hock Mountains, falls into the South Atlantic Ocean at St. Helena Bay, on the west coast. In the neighbourhood of the Paarl it is tame and uninteresting, for its banks are treeless and monotonous-looking, contrasting forcibly with the fine, bold scenery of the mountain-ranges on either hand, and the

softer beauty of the town itself. We could scarcely form an estimate of the width of the valley, which may perhaps be two or three miles across; but it appeared to be a flat, sandy plain throughout, ornamented only by a low, shrubby vegetation, which seemed in many places very sparse and thin. On the opposite side to the Paarl Mountain runs the lofty chain of the Drakenstein, displaying much grandeur of outline and variety of configuration, but everywhere treeless, naked, and barren; apparently a series of precipitous crags and peaks of glittering sandstone, with here and there a tall, snow-capped summit standing out in bold relief from the deep azure of the distant sky. To the right and left huge mountains still meet the view, and the valley is almost entirely encompassed by these towering boundaries of rock.

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Next morning, just as I had finished dressing, Hendrick put his head into my room, and began to reproach me for spending the "best part of the day in bed," the hour being then only seven o'clock. Every man, they say, is mad on some point, and Hendrick's peculiar lunacy is a fondness for getting up in the middle of the night, and walking for several miles before any other Christian or infidel has roused himself from his nocturnal slumbers. Just such a feat had he been performing on the occasion alluded to, and it was not to be wondered at that his appetite was alarming in the extreme. However, Johannes, the attendant-spirit of the hotel, was very prompt in his measures on that morning, and ere long we sat down to a sumptuous breakfast. As soon as Hendrick could afford time from the eating and drinking for conversation, he informed me that he had been half way up the mountain at six o'clock, and he wound up with a proposition that we should devote the rest of the day to more extended explorations in the same direction.

The Paarl Mountain is one of the celebrities of the place, and so I was fain to agree to my companion's proposal, albeit I felt uncommonly lazy, and the day promised to be exceedingly hot; a promise that was amply redeemed before the sun had reached the zenith. However, after breakfast we started, and soon had commenced the ascent, for the foot of the hill was scarcely five hundred yards distant from the hotel. The path upwards was well marked, clear of grass and bushes, but steep, and almost slippery, the red earth having been worn quite smooth by being constantly walked over, and baked hard by the hot sun. As may be supposed, we paused frequently, for in such weather the climb was rather hot and fatiguing; and during these halts we had ample opportunity for studying the beautiful landscape afforded by the lovely Paarl, nestling in

the valley at our feet, with its glorious background of high and rugged mountains.

In due course of time we reached, not exactly the summit, but one of the shoulders of the mountain; for the former, a somewhat semicircular mass of smooth granite, is not easy of access from the side on which we approached it; and there, again, we paused to look around us. On our right a small rivulet was winding downwards through a rocky ravine, fern-clothed and shaded by dense clusters of small shrubs, amongst which the elegant and graceful sugar-bush (*Protea nana?*) was most abundant; its large rose-coloured blossoms affording immense attraction to many sun-birds, whose weak but pleasing notes we heard everywhere about us. There were three species in tolerable plenty—the dark green one (*Cinnyris famosa*), one with a green head, orange breast, and grayish body (*Cinnyris violacea*), and a third, much larger than the other two, and more plainly dressed, with a long tail (*Melliphaga Caffer*).* The scarlet flowers of the wild sacha (*Leonotis leonurus*) peeped out every here and there from the clumps of rank vegetation, which almost shrouded portions of the little brook from the daylight; and other blossoms, equally beautiful though of less striking colours, were very numerous. There were not many birds visible, excepting those I have already mentioned; a few sparrows (*Passer arcuata*); a flock or two of those lovely little long-tailed whidah-finches, the *Vidua erythrorhyncha* of Swainson, which is known in some parts of the colony by the extraordinary appellation of "king of the Jews"; and, near the summit of the ridge, a pair of my favourite little gray finches (*Fringillaria vittata*), called by the Dutch settlers "streepkopje." I saw very few butterflies; only one specimen of *Acræa horta*, and two or three of the very beautiful and very common *Pyrameis cardui*, displaying their usual fearlessness, and permitting me to approach quite close to them without any seeming alarm.

On our left was the summit of the mountain, a huge, naked rock towering up for fully fifty or sixty feet above us, with precipitous sides and, apparently, a rounded top. Behind us the land dipped for a short distance, and then rose again gradually, sloping upwards towards two immense semicircular masses of the same imperishable granite, considerably higher than the peak which is visible from the town. Standing within a short distance of one another, and rising far above the surrounding vegetation, these two smooth, bald-headed mountains were most striking objects, and we soon resumed our walk and strode over to them. The ascent of the one upon our left

* I am indebted to the kindness of my friend E. L. Layard, Esq., the Curator of the South African Museum, for the names of these and many other birds.

seemed feasible enough, but it was so girt with tremendous precipices, that we did not like to risk the slippery footing on the smooth, naked granite ;* the other, from the side next to us, was utterly beyond our powers of climbing. Save the hard gray lichens which covered the stone profusely, and a patch or two of some tiny moss in the crevices here and there, not a shred of vegetable life was visible beyond a certain point; and the line of demarcation between rock and verdure was very strongly apparent. Just where the latter ended we found some beautiful yellow *Oxalidæ*, and a very lovely white sundew (*Drosera trinerva*),† which was just unfolding its exquisite little flowers. Here, also, were many clumps of the common English chickweed (*Stellaria media*), an old friend amongst the strangers that grew around.

In the shallow valley between the two mountain ridges, there were numbers of huge boulders confusedly scattered over the ground, some of which were of such gigantic size as almost to constitute small mountains in themselves. An enormous slice, apparently from the summit of the peak, was resting against one of these great rocks, and the two combined to form a spacious cavern, seemingly almost rain proof, and possessing a hard, smooth flooring of dry earth: we paced this natural apartment, and found it to be about six feet in length, by about four or five in width. It was evidently a place of continued resort, for the walls were inscribed with many names. On our return we were told that this was only one of several caverns which are to be found on the curious mountains.

The gorge between the two summits was very narrow at first, but it widened rapidly as we advanced, until it opened into an undulating plain at the foot of the mountains on the other side. It was full of trees and broken rocks, and a little stream ran dancing down the descent into the plain I have mentioned. We passed through the narrowest part of the defile, and seated ourselves beside the little brook, whose crystal waters were splashing merrily down the hill-side, between patches of green and luxuriant moss begemmed with wild-flowers of rare beauty, amongst which the exquisite little sundew I have mentioned, was most abundant. It was a charming spot, and we appreciated its loveliness to the fullest extent. Behind us rose the enormous and almost naked masses of the mountains, towering upwards in all the pride and majesty of

* On a subsequent occasion I ascended this peak, and found that the danger was more imaginary than real. The rock is so rough and scored by the weather that it affords tolerably secure footing, and the noble view, obtained from the summit, amply repays one for the climb.

† I have to thank the colonial botanist, the Rev. Dr. Brown, for his kindness in naming this plant for me.

the primitive granite: at our feet, the gurgling waters of the stream were wandering away through the tangled vegetation down to the level of the plain (or rather, a succession of billowy undulations covered with some sort of grass, and ornamented, here and there, with trees and bushes of many kinds), which was spread out like a map before us, and bounded in the distance by other hills again. The picture thus presented to us must surely be, at all times, a lovely one; and how much more charming than usual when seen under the influence of such glorious weather!

During the hour that we spent at this sweet spot, a large black and white eagle was sailing about the summit of the mountain, apparently to the great annoyance of a pair of hawks, who, every now and then, attacked the royal bird most savagely, uttering harsh screams of anger as they approached him; and, although they did not succeed in driving him away from the place, he had such a wholesome dislike to a combat with them at close quarters, that, whenever they manifested hostile symptoms, he invariably retreated. He was a large specimen of *Aquila Verreauxii,* and his persecutors a pair of rock kestrils (*Tinnunculus rupicolus*). From this place we had a good view of the two large rocks, and of their rifted and furrowed sides, in some places so high and perpendicular, as to be apparently inaccessible even to the krantz-loving baboons.

After luncheon we descended to the rolling country I have alluded to, and, eventually, returned to the Paarl by a ravine that lies a little north of the peak. With the exception of the three species of sun-birds that I have before mentioned, and a covey of red-winged partridges (*Francolinus Le Vaillantii*), which we flushed amongst the protea bushes, we saw no living creature during the remainder of the walk; however, the curious masses of rock which were scattered about everywhere, and the variety of plants rendered the ramble sufficiently interesting. We saw one fine specimen of the waggon-boem, or *Protea grandiflora,* and a few of the beautiful silver trees (*Leucadendron argenteum*), which are so abundant on Table Mountain. In the ravine a small stream of water, almost hidden by the branches of the trees that grew on either side of it, dashed furiously over the rocks, amidst piles of luxuriant ferns of many kinds, on its way to the river below.

We enjoyed the most excellent dinner which Mynheer Schmidt set before us, as we deserved to do after our long ramble, and retired early to rest, resolved to start next morning for Wellington.

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We left the Paarl by the 9.47 train and reached Welling-

ton, distant nine miles, at 10.14. Though a picturesque village with some fine mountains in its vicinity, it is not equal to the Paarl in beauty. The hills are further off; the trees are not so fine or so numerous; and the site of the place is less romantic: in short, the grouping of the scenic elements is not so striking, and it is decidedly less attractive in its general features than its older and more celebrated rival.

We stayed but a short time at this place, and then left for Darling Bridge, through the famous pass called Bain's Kloof, in honour of the engineer who planned and constructed the magnificent road across the Drakenstein Mountains.

I question if there is a wilder drive in the whole of Cape Colony than that through Bain's Kloof. It commences just beyond Wellington, winds slowly upwards for about seven miles, and then gradually descends again to Darling Bridge. I do not know the distance between the two places, but I should imagine it is at least twelve or fourteen miles. The road is scarped out of the mountain-side, and, though broad and safe, is very suggestive of danger in many parts, where the rocky incline slopes suddenly down to the deep valley of the river, which winds along in the very bottom of the enormous ravine. As both the ascent and descent are sufficiently gradual, the road is necessarily very winding in its course, and a succession of wild and magnificent, though limited, views are presented throughout. The solemn stillness of the tremendous kloof is almost as remarkable as the strikingly barren and desolate aspect of the rough mountain-sides, destitute of trees or almost any other vegetation, excepting that characteristic of the most stony wildernesses of the country. Proteas of many species, and the everlasting Rhinosterbosch (*Elytropappus rhinocerotis*) abound, and it would not be exaggeration of much magnitude to say that these plants are the sole representatives of the vegetable world in this gloomy pass. For the first part of the drive the road is planted on the outer side with young oak-trees, which promise in the future to add much to the beauty of this magnificent highway.

The valley of the river at Darling Bridge is a swamp, in which are growing quantities of the strange-looking palmiet (*Prionium palmita*), with its enormously thick, spongy stems. Pools of water abound, like those in an Irish bog, and quite as treacherous in appearance, though there did not seem to be much actual difficulty in getting through them. On either side of the narrow valley are high, grand mountains, very rugged, and very picturesque, but bleak and savage-looking.

The Darling Bridge, whence the place takes its name, was carried away some time since, and it has not yet been repaired. The hotel is the only house within sight, but its interior

showed many evidences of civilization that we were not prepared to meet with in such a wilderness; there were pictures and periodicals, and actually one of the latest numbers of the London *Times*, as well as several cabinets of insects tastefully arranged and in beautiful preservation.

We returned to Wellington the next morning, where we were detained by rain for a day and a half.

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At Wellington we heard a good deal of a lake in the Tulbagh district, called Vogelsvlei, which was said to abound in wild-fowl, and after making due allowance for exaggeration on the part of our informants, we decided that it would be worth our while to pay this noted sheet of water a short visit. Accordingly, having re-chartered old Howard's cart for three days more, away we went.

After a pleasant drive of about fifteen miles over a better cultivated country than I had yet seen at the Cape, we arrived at Retief's Hotel, close to Koopman's River. This stream is a tributary of the Great Berg, and I believe it rises in the Tulbagh range of mountains. At low water it is an insignificant brook, but when full, they told us, its passage is sometimes an impossibility without a boat. The hotel is a solitary building, kept by a Cape Dutchman and his brother. It is a snug little place, and the proprietors were most civil and obliging; everything that they could possibly do for our comfort was done freely and gladly, with genuine hospitality, and their charges were moderate in the extreme.

In front of the hotel, at the distance of about a quarter of a mile, runs the Great Berg River, and considerably beyond it, the bold and picturesque mountain called Riebeck's Casteel forms a most imposing object. In the opposite direction, three or four miles behind the house, are the noble, but barren-looking hills of the Tulbagh range, the tall peak of the Winterberg * rising above them all, in the left distance, and flashing back the sunlight from its snow-covered summit. Near the foot of these mountains lies the Vogelsvlei, which, however, is invisible from the hotel, owing to the lowness of its position.

At the time of our visit the place was gay with multitudes of bright-hued flowers, principally the blossoms of many genera of the world-renowned Cape bulbs: *Oxalidæ* of several kinds; the scarlet blood-flower (*Hæmanthus coccineus*); the South African tulip (*Homeria collina*), a lovely, but most poisonous plant, resembling somewhat in shape our common daffodil; ixias and gladiolas of many species; *Babianæ;* and the magnificent trumpet-lily (*Richardia Æthiopica*).

* 6,840 feet above the sea level.—*Hall.*

When we arrived on the spot we found that the chances of sport were very far from being as great as we had been led to believe. Our host informed us that there were plenty of geese and ducks, but that they were most difficult of approach; that the lake was private property; and, finally, that there was no boat on it. Formidable as were these obstacles at first sight, they were eventually smoothed away without much difficulty. The Retiefs declared they could get leave for us to try our guns amongst the birds, and they offered to put their own punt into a waggon and take it to the vlei for our especial benefit. No sooner said than done! Hendrick and I were not long in deciding to follow out the plan suggested by our hosts, and immediately after breakfast we proceeded in a body to the farm-yard, where the punt was lying; a waggon with four horses was already inspanned, so that we had nothing to do but lift the boat into it. Our own cart was also prepared for us at the same time, and in about ten minutes we had started, Mr. Franz Retief, the younger of the two brothers, having volunteered his services as guide for the occasion. The distance between the hotel and the lake, probably about three miles, was accomplished without anything strange occurring, and on our arrival there, the old Dutchman who was said to be the owner of a portion of it, politely expressed his pleasure at being able to meet our wishes, and begged to be allowed to join the party. This was of course agreed to, and it was then arranged that four of us should go in the punt, Franz Retief to propel the vessel, and the rest of us to shoot.

The lake, or vlei, lies close to the foot of the mountains, and a good deal below the level of the surrounding country. It is totally devoid of beauty, and in point of fact, is simply an enormous shallow pond, with muddy banks and dirty-looking water. At the southern end, where we embarked, there is a stretch of marshy land, with reeds and other aquatic plants growing in it, which looked a likely place for snipe, and we promised ourselves a tramp through it after we had disposed of the wild fowl. There were numbers of ducks and geese on the vlei, the latter in small parties of about seven or eight, but we did not see any flamingoes, which we had been told were plentiful at certain times. The mud was soft and tenacious at the edges of the vlei, and the launching of the punt was a work of greater difficulty than the lifting of it into the waggon had been; however, after some resolute pushing, and a fair quantity of slipping, we got the little craft afloat, and then scrambled on board.

When we were fairly under way, we began to wonder how we were to get within range of such wary birds as geese and ducks, in an open lake without cover or disguise of any kind:

however, our guide appeared very sanguine, so we said nothing, but watched curiously his mode of pursuit. To our intense astonishment, he pulled straight for the nearest flock of geese. Two or three ducks, which were swimming about in the neighbourhood, took wing, and were soon out of sight, but the geese seemed either fascinated, or more stupid than geese ever were before, for they made no attempt to fly. They swam away from us, certainly, but otherwise showed no disposition to avoid us.

"What does it all mean?" said Hendrick to me. "Why don't they fly?" I asked of Franz Retief. "Can't fly," answered he, "they have lost the long feathers of their wings." O, ye gods! what an announcement! what a downfall to all our hopes of sport! Hendrick looked disgusted, and laid aside his gun; but, in another moment, Retief cried "Look out!" and, as he spun the punt half round until she was broadside on the troop of geese, the temptation was too strong, even for Hendrick. The birds, on the calm surface of the waters, seemed larger than they really were, and we forgot all about their wings and their supposed helplessness. Bang! bang! went both our guns—unluckily, at the same bird,—which turned up, and died satisfactorily. The remainder did not give us a chance, for, in an instant, they were gone! not into the air, but into the water; where they stayed so long that we began to suspect they were amphibious. When they reappeared, they were scattered all around us, well out of range. Having secured the dead bird, Retief put the punt about, and went after the nearest of the broken flock. But the knowing creature had learnt a lesson, and as soon as we approached him, down he went amongst the fishes, and taking a swim underneath the surface, he reappeared still further off. Retief caught sight of his head the moment it came up, and, bending to the oars, sent the punt dashing through the water in pursuit. After a long chase we shot him, and, when we had added seven more to our list, we had almost come to the conclusion that, for these geese, wings were unnecessary appendages, considering how uncommonly well they managed to baffle our attempts to shoot them.

Notwithstanding their activity, and the difficulty of getting near them, however, there was really no sport in slaying them under the circumstances; so, when we had bagged a sufficient number to supply a few of our friends with roast-goose for dinner, we landed and commenced the much more congenial occupation of walking up the snipe. Promising as the place looked, however, the result proved that it was almost uninhabited by the long-bills. I had tramped about for fully three-quarters of an hour, floundering through the shallow

water and greasy mud, before the familiar *skeap! skeap!* struck on my ear, and I caught sight of one of my pretty friends, having flirted up behind me, skimmering along towards the mountains. It was a cross shot and an easy one, so I had the satisfaction of pocketing his snipeship before many seconds had elapsed. Hendrick, who was some distance to my right, soon turned up another bird, and, after two hours, we returned to our cart with six couple, having, I believe, found all the birds in the place and killed the lot. The Cape snipe is, I imagine, *Gallinago nigripennis*,* and the species of goose that fell to our guns this day was the *Chenalopex Ægyptiacus*, or mountain goose:† the unfortunate birds were moulting, and were destitute of their primary quills at the time of our visit.

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We had a most delightful drive back to Wellington. The sky was cloudless, the air cool and grateful, and the whole country magnificently green and fresh after the heavy rain of the previous days. Flowers, too, of the brightest colours bespangled the ground in myriads. Some of the fields were literally vast sheets of pink and yellow from the multitudes of oxalis blossoms, and, every here and there, the scarlet corollas of the blood-flowers (*Hœmanthus coccineus*) or of *Watsonia angusta* peeped from the green herbage on the road sides. Gazanias of a lustrous orange were wonderfully abundant, the handsome spikes of *Satyriun erectum* were just bursting into bloom, and several species of protea, with their large and elegant flower heads, almost covered the waste ground. At one part of the drive, the air was laden with a most delicious scent like that of *Coumarouna odorata* or Tonka Bean. At first we could not imagine where it came from, or what was the cause of it, but a few minutes' search showed us a small vlei perfectly white with the odorous flowers of *Aponogeton distachyon*: it was situated in the centre of a little verdant glade, round the edges of which were luxuriant copses of wild olive (*Olea verrucosa*) and other trees, grouped in the most graceful manner. Such a charming spot it was! Hendrick and I agreed that we had seen nothing more lovely during our tour.

* Vide *Ibis*, vi. 355.

† Dr. Kirk (*Ibis*, vi. 336) says "this is the worst of all the Duck kind for the table, being in many cases quite uneatable," but those which we shot at Vogelsvlei were excellent.

ANCIENT SUPPLY OF WATER TO TOWNS.

BY THE REV. W. HOUGHTON, F.L.S.

"Ἄριστον μὲν ὕδωρ," says Pindar, in his first Olympian hymn, and, if the poet's words be restricted to wholesome water, no exception can be taken to them; but if unwholesome water be the subject of remark, then the expression *κάκιστον μὲν ὕδωρ* is most true. The ancient Romans, though they knew nothing of the composition of water, and in matters of science were for the most part mere babes when compared with the scientific men of our day, yet unquestionably surpassed us in the matter of a supply of water to their cities. The enormous quantities of water conveyed, often from great distances, to ancient Rome by the magnificent system of aqueducts, the costliness and efficacy of the works themselves, fill us with astonishment, and ought, at the same time, to fill us with shame for allowing ourselves, in this boasted age of social progress, to come so lamentably far behind the ancient Romans in a matter whose importance it is not possible to exaggerate. The ancients justly prided themselves on their water supplies. Pliny is enthusiastic in his admiration of the system of aqueducts that supplied Rome: "If we take into consideration," he says, "the quantities of water brought into the city for the use of the public, for baths, for fishponds, for private houses, for canals, for gardens, for places in the suburbs, and for country residences, and then reflect on the arches that have been constructed and the distances traversed, the mountains that have been pierced with tunnels, and the valleys that have been levelled, we must admit that there is nothing more worthy of admiration in the whole world." Were the Roman naturalist suddenly to appear amongst us now, we can conceive what expressions of unbounded delight and surprise would proceed from his lips as he gazed on our mighty steamboats, our railroads, gasworks, the Atlantic telegraph, enabling men of two different worlds, thousands of miles apart, to speak almost as if face to face. But the system which provides the Metropolis and some other towns with water would most assuredly stand out in strong contrast to the other wonders of this age, and sink into insignificance when compared with the aqueductal system of Rome in the time of the Emperors.

The earliest notice of channels for the conveyance of water occurs in the sacred writings. Thus we read of "the conduit of the upper pool in the highway of the fuller's field" (2 Kings xviii. 17), of "the upper watercourse of Gihon" (2 Chron. xxxii. 30). The Hebrew word translated "conduit" is תעלה

(teâlâh), which Fürst derives from an unused root signifying to "bend inward," "to sink," hence, "to be hollow," or "deep." The Septuagint has ὑδραγωγός, a word of similar meaning as the Latin aquæductus. It is probable that the aqueduct for conveying water to Jerusalem from the pools near Bethlehem which Solomon made, portions of which still exist, was constructed by the orders of that king. According to Pococke, "The aqueduct is built on a foundation of stone; the water runs in round earthen pipes, about ten inches in diameter, which are cased with two stones, hewn out so as to fit them, and they are covered over with rough stones well cemented together, and the whole is so sunk into the ground on the side of the hills that in many places nothing is to be seen of it." Jerusalem appears to have been always well supplied with water, either by natural springs or by artificial modes of conveyance from "pools" into reservoirs excavated out of the rock. "Like Mecca," Mr. James Fergusson writes, "Jerusalem seems to have been in all ages remarkable for some secret source of water, from which it was copiously supplied during even the worst periods of siege and famine, and which never appears to have failed during any period of its history."* Tacitus in a few words describes both the natural and artificial supplies of water in Jerusalem: "Fons perennis aquæ, cavati sub terra montes, et piscinæ cisternæque servandis imhibus." A perennial spring of water, subterraneous caverns scooped out of the mountains, pools and tanks for collecting rain-water (*Hist.*, v. 12). The ancient Greeks, according to Strabo (*Geog.*, iii. 5, 7, 8), held in very little esteem (ὠλιγώρησαν) such works as paving roads, constructing sewers and aqueducts. There were certainly numerous springs and fountains in ancient Greece, and the inhabitants were for the most part content to draw from these, though we can hardly suppose that they found these natural supplies sufficient. So essential were fountains considered, that Pausanias questions the propriety of "calling that a city in which there is no supply of water" (ὀυχ ὕδωρ κατερχόμενον ἐς κρήνην). The same writer speaks of a fountain at Megara, built by Theagenes, "which was well worthy of inspection, both on account of its size, ornamentation, and the number of its pillars." Corinth, certainly, was well supplied with water; numerous baths were made, some at the public expense, others at that of the Emperor Adrian; a "magnificent one, adorned with various kinds of stone, stood near the temple of Neptune." To pass over several other allusions to fountains, we may notice the *ennea krounos* (nine pipes) at Athens. Athens appears to have been badly supplied with good drink-

* Smith's *Dictionary of Bible*, i., p. 1028.

ing water, and was far inferior to Rome, both in its houses, streets, sewers, etc. Dicæarchus, who visited Athens (*circ.* B.C. 400), speaks of it as being "dusty, badly supplied with water, badly laid out on account of its antiquity, most of the houses mean, and only a few good." There were many wells in the city, but the water, being of a saline nature, was not good for drinking, though of course much used for domestic purposes. The *ennea krounos* was originally called *callirhoë*, when the springs were open (*Thucyd.* iii. 15), but the Peisistratidæ converted this natural spring into an artificial supply, by laying down conduits or pipes, so that *ennea krounos* was the architectural term, *callirhoë* that which denoted the natural spring. "The spring flows from the foot of a broad ridge of rocks which crosses the bed of the Ilissus, and over which the river forms a waterfall when it is full, but there is generally no water in this part of the bed of the Ilissus, and it is certain that the fountain was a separate vein of water, and was not supplied from the Ilissus. The waters of the fountain were made to pass through small pipes pierced in the face of the rock, through which they descended into the pool below. Of these orifices seven are still visible. . . . The pool which receives the waters of the fountain would be more copious but for a canal which commences near it, and is carried below the bed of the Ilissus to Vunó, a small village a mile from the city, on the road to Peiræeus, where the water is received into a cistern, and supplies a fountain on the high road and waters gardens. The canal exactly resembles those which were in use among the Greeks before the introduction of Roman aqueducts, being a channel about three feet square cut in the solid rock."* It certainly does seem somewhat remarkable that the ancient Greeks should have been so completely surpassed by the Romans in this respect, for it is clear that the Greeks were not deficient in engineering skill, as is witnessed by the two artificial tunnels or *emissarii* (portions of which are still to be seen), which in very early times were pierced through the rock in order to carry off the water from the lake Copais in Bœotia. The deepest of these tunnels is thought to have been from 100 to 150 feet, and nearly four miles long.

The early inhabitants of Rome got their water from the Tiber and wells sunk in the city; but as the population increased, and as, perhaps, they found the supply from these sources unwholesome for drinking purposes, they had recourse to that magnificent system of artificial supply by means of

* See Leake's *Topography of Athens*, and Appendix xiii., "On the Supply of Water at Athens." Smith's *Dictionary of Greek and Roman Geography*, Art. Athenæ.

aqueducts which has never since been equalled by any people.

From Frontinus, who, in the time of Nero, was nominated to the honourable post of *Curator aquarum* (A.D. 97), we have a most ample account of ancient Roman water supply. According to this writer, the date of the first aqueduct is assigned to the year A.U.C. 441, or B.C. 313; others gradually were constructed, partly at the public cost, partly by the munificence of private persons, till, in the time of Frontinus, they numbered nine, and were afterwards increased to fourteen in the time of Procopius (*circ.* A.D. 360). The most remarkable of these aqueducts were the Aqua Appia, the old and new Anio, the Aqua Marcia, and the Aqua Claudia. The sources of the Aqua Appia (so called because commenced by the censor Appius Claudius Cæcus) were near the Prænestine road, about eight miles from Rome. The aqueduct, after making a circuit of about 780 paces to the left, was carried under the ground for about eleven miles, till it entered the city at the Porta Capena, from which place to the Porta Trigemena, about sixty paces, it was on arches; it delivered its water into the Campus Martius.

The old and new Anio aqueducts took their names from the river of that name; the water of the former was taken from the river about thirty miles from Rome, not far above Tibur. It should be borne in mind that the Romans, with a view to check the too rapid flow of water in straight channels, used to take them by circuitous routes; so that the length of aqueduct was generally considerably more than the distance of the source from the city. The old Anio aqueduct was very winding, and its whole length about forty-three miles, scarcely a quarter of a mile of which was above ground. Remains of this aqueduct are still to be seen near the *Porta Maggiore,* near Tivoli. The new Anio aqueduct was commenced by Caligula (A.D. 36), and finished by Claudius (A.D. 50). It began at the forty-second milestone, and was about fifty miles long; for the greater part of its length the Aqua Anio was subterranean. Some of its arches were more 100 feet high.

The Aqua Claudia was also finished by Claudius; it derived its water from two springs of most excellent water, called Cærulus and Curtius, about thirty-eight miles from Rome. For the space of thirty-six miles it formed a subterranean stream; for nearly eleven miles it ran along the surface of the ground, and it was supported on arches for the space of about seven miles. Near Rome these two aqueducts were united, forming two separate channels on the same arcades, the Anio Novus above and the Claudia below. The Aqua Claudia still forms one of the chief supplies of water to the

modern city; from the excellent quality of which it has received the name of *Aqua felice.*

The Aqua Marcia supplied the best water of all the Roman aqueducts; that brought by the old Anio from near Tibur was not fit for drinking, and it was in consequence of this, and its bad repair, that the senate commissioned Q. Marcius Rex, the prætor (B.C. 144), to build another aqueduct, which was afterwards called after him. The Aqua Marcia commenced thirty-six miles from Rome; the greater part of it was under ground; the arcades were seventy feet high, and it supplied the Capitoline Hill with water. When we consider the great number of aqueducts which poured their waters into Rome, some for drinking purposes, others for baths, *naumachia*, etc., etc., we can realize the words of Strabo, that whole rivers flowed through the streets of Rome. Supposing all the aqueducts to have been in operation at the same time, it has been roughly calculated that they would have supplied fifty million cubic feet of water daily. Taking the population of Rome to have been one million, each inhabitant might have had fifty feet every day.

The aqueducts were built with very strong masonry; the channels were made of brick or stone, and lined with a coating of cement. They were arched over, in order to keep the water pure and safe, and to exclude the sun and rain. The covering was generally an arched coping; holes were made at regular intervals in the coping to provide a vent for the air, which would otherwise have burst the roof or walls of the channel by its compression. Reservoirs were generally constructed at different points on the aqueduct in order to catch any deposit or sediment contained in the water. A vast reservoir, called *castellum*, received the water when it reached the city, from whence it flowed into other *castella*, whence it was distributed for use by the inhabitants.

But not alone in Rome did a magnificent aqueductal system obtain; it was extended through all the large cities of the vast empire. At Antioch, at Pyrgos, near Constantinople, at Metz, at Nismes, at Segovia in Spain, may still be seen relics of Roman grandeur. "The aqueducts of Rome," says Montfaucon, "were, without doubt, wonderful, on account of their great length—arcades continued over the space of forty or fifty miles; their great number, with which the Campagna of Rome was filled on every side, all this surprises us. But it must be confessed that if, without considering the total extent, we only look at any of the parts which remain round Rome, there is nothing that approached the aqueducts of Metz, of Nismes (Pont du Gard), or of Segovia." The aqueduct of Metz extended across the Moselle, and conveyed water

from near the village of Gorse to the city, a distance of about six French leagues. About twenty arches of this great work still remain. Naval fights were frequently exhibited on water supplied by this aqueduct.

The two great modern schemes for supplying the metropolis with water are those of Mr. Bateman and Messrs. Hemans and Hassard. The former gentleman proposes to bring the water from the Welsh hills—the sources of the Severn—a distance of 183 miles; the other project is to bring the water of the lakes in the north of England, a distance of 240 miles from London. As to the respective merits of these bold projects we offer no opinion. The question of an abundant supply of pure water to the metropolis is one whose importance is becoming every day more and more felt, and we trust that after the Reform question is settled, the Government will turn their immediate attention to the future water supply of London.

ON THE BOTANICAL ORIGIN OF WHEAT.

BY JOHN R. JACKSON,

Curator of Museum, Royal Gardens, Kew.

The origin of species is a subject which has recently occupied the attention, more or less, of every thinking man. The opening of this question is chiefly due to Mr. Darwin, the appearance of whose book some few years since caused such a sensation in the scientific world. What changes or variations have been proved or supposed to have taken place in the animal kingdom we are not prepared to discuss; we know that a strong inclination prevails amongst many, perhaps most, botanists of note to accept Mr. Darwin's theories abstractedly, if not in their entirety, and lumping is more in fashion just now than splitting. No doubt much good will be derived from this system, which is now being adopted in most botanical works of authority, and it will help much to facilitate the study of plants to a beginner. It is an old story how that our choice cultivated forms of apples look to the common crab as their first parent, or the numerous varieties of plums came from one common stock. These are facts which, having become popularly known, are consequently accepted as true; but the question as to the origin of the most important of all the cultivated plants of Britain, namely, the wheat, is one of very

difficult solution. That wheat was known in very ancient times is admitted by all; but from what country it originally came, as well as from what plant it originally sprung, is still a controverted point. The cultivation of wheat, as we all know, is coeval with the history of agriculture itself. It is said to have been found wild in Asia Minor, but great doubt exists as to its native country.

Wheat is now known to the botanist as *Triticum vulgare*, of which, however, there are a whole multitude of cultivated varieties. The most prominent or best distinguished forms are *T. æstivum* (Lin.), *T. hybernum*, and the spelt wheat, *T. spelta*. Of the genus Triticum we have two species natives of Britain, *T. repens* and *T. caninum*, under which the other species formerly described in British Floras are now sunk. The first of these, the couch-grass, is a common and too well-known plant to agriculturists, owing to the great difficulty experienced in extirpating its long creeping roots, which exhaust and impoverish the ground. *T. caninum* comes nearest to it in point of botanical characters, and the best means of distinguishing the two is by the fibrous root of the latter, compared with the creeping rhizome of the former. *T. repens*, however, has shown itself to be capable of changing its characters considerably in different situations. In some the awns are found bearded, while in others they are beardless.

A field of corn is always a pleasant sight, even when the blades have only just sprung from the ground, and are fresh and green with vigorous growth; but when the flower-spikes have reared their lofty heads often to a level with our own heads, and have changed their colour from green to the characteristic golden brown, and have become weighted with their heavy seeds, bowing with every breeze, a corn-field is in its greatest beauty, and is justly one of the happiest additions to an English landscape.

The question as to what was the original or wild state of wheat is one of very great interest, and one which has occupied the attention of many botanists, both British and foreign. Much has been written, and, perhaps, more especially by continental botanists, to establish the theory of the origin of wheat from *Ægilops ovata*, and, on the other hand, to refute it. Amongst English botanists, the late Professor Henfrey paid particular attention to the subject; but it would seem that the idea of *Ægilops triticoides* being a hybrid production of *Ægilops ovata* was first made known by Dr. Regel, of the Imperial Botanic Garden, St. Petersburgh. Experiments that have since been conducted in crossing these plants with wheat have proved satisfactory, so far as the greater development of the plants could be anticipated in so short a space of time,

though, on the contrary, we have records of similar forms of grass being under cultivation for four years, which, though they produce fertile seeds, never had the least apparent inclination to become wheat.

M. Fabre, of Agde, has conducted some most interesting experiments in the production of wheat from *Ægilops ovata,* the results of which were a taller growth of the plants generally, a greater development and enlargement, as well as a more regular growth of the ears, and a consequent enlargement of the seeds; indeed, we have seen some seeds of *Ægilops ovata* that would even pass muster for the immature seeds of a poor description of wheat. The chaff-scales also under cultivation modify their character to that of wheat, and the number of awns are likewise lessened. Thus M. Fabre has endeavoured to show that *Ægilops triticoides* is produced from *Ægilops ovata,* and in a further period of about six years that wheat can be produced by cultivation from *Ægilops triticoides.* As a still further proof of the accuracy of these experiments, we may quote the following account of a similar trial made and recorded by Professor Buckman, then of the Royal Agricultural College, Cirencester:—

"In 1854, we planted a plot with seed of *Ægilops ovata,* from which was gathered seed for a second crop in 1855, leaving the rest of the first plot to seed itself, which it did, and came up spontaneously. This plot has since continued to bring forth its annual crop in a wild state in which the spikes are short, and so brittle that they fall to pieces below each spikelet the moment the seed is at all ripe. The produce of the 1855 crop has, in the same manner, been cultivated year by year in different parts of the experimental garden of the Royal Agricultural College, and our crop for 1860 had many specimens upwards of two feet high, and with spikes of flowers containing as many as twelve spikelets. Our conclusions then are, that with us the *Ægilops* is steadily advancing, and we fully expect in three or four years to arrive at a true variety of cereal wheat. What, too, is confirmatory of this matter is, that the bruised foliage of the wild grass and the cultivated wheat emits the same peculiar odour; and, besides, the *Ægilops* is subject to attacks of the same species of parasites."

These parasites are small microscopic fungi, known to the agriculturist as rust, mildew, etc., or more commonly spoken of as blight. "These," Professor Buckman continues to say, "seem to be the effects of civilization; and it is not a little remarkable that, in this respect, this grass should be so much like our field crops, which were particularly liable to blight in the straw and foliage during 1860."

Ægilops triticoides has by many botanists been referred to

a hybrid form of *Ægilops ovata,* and from its nature and habit it seems to stand between it and wheat, and thus form a connecting link, for the plants are found mostly on the borders or in the neighbourhoods of corn-fields, and never in situations far removed from cultivated wheat; and the fact of its being scattered about in small quantities in different localities in the south of France would seem to indicate that corn-fields existed in the neighbourhood at one time.

Dr. Godron, a continental botanist, who has paid some attention to this subject, says:—"It is well known that the spike of *Ægilops ovata* breaks at its base when mature, that it does not become separated into pieces, and that it preserves its seed tightly fixed to the floral envelopes. This spike is introduced into the soil all in one piece, and the four seeds it contains give birth in the following year to four plants of *Ægilops,* distinct from one another, but with their roots interlaced, and forming by their union a little tuft. Ordinarily, all these seeds produce the parent plant; but sometimes one of the seeds gives birth to a plant very distinct from the first, and having an aspect which reminds us of cultivated wheat. This is *Ægilops triticoides.* This very interesting fact, ascertained by M. Fabre, I have often verified in the vicinity of Montpelier. M. Fabre took the resolution of sowing the seeds of *Ægilops triticoides,* and followed through twelve successive generations the products furnished by the seeds originally gathered from this wild grass. The plant assumed by slow degrees a taller growth, the spike became larger, it ceased to be brittle at the base, its glumes lost one of the two awns which distinguish *Ægilops triticoides*; in a word, this plant acquired, in part at least, the characters of wheat."

Dr. Godron, however, seems to be opposed to the theories of M. Fabre, and himself conducted a series of experiments, which, according to his showing, bore out his views. He says that it is "evident that *Ægilops triticoides* is nothing else than a hybrid resulting from the accidental fertilization of *Ægilops ovata* by *Triticum vulgare,* and in support of this proceeds to describe the results of his experiments. The first was made by scattering the pollen of *Triticum vulgare muticum* over the spikes of *Ægilops ovata,* in which the flowers were about to open, and at the period when it penetrates more readily into the flower, from the fact that the glumellæ of the *Ægilops* separate naturally to about the twenty-fifth of an inch. Out of six spikes so operated upon, and which were carefully gathered as soon as ripe, and the seeds sown in the following spring, five of them produced *Ægilops ovata* exclusively, the remaining one also produced stems of the same: "but one of the seeds gave birth to two stems much taller than those of

the parent plant, and the spikes of these presented the most perfect resemblance to those of that variety of *Ægilops triticoides*, in which the awns are half abortive, and as it were rudimentary." The second experiment was conducted by carefully opening the glumellæ of the *Ægilops* to such an extent as to admit a fine pair of forceps, and with these to extract the stamens and substitute the anthers of *Triticum vulgare muticum*. These anthers were selected from those just ready to open, so that the foreign pollen might be taken at once by the stigma. After the insertion of these anthers, the flowers were gently pressed together again, and left to fertilize. The result of this experiment was the production of plants of *Ægilops triticoides* from all the seeds ripened from the flowers experimented upon. The third experiment was conducted by removing the anthers from four spikes of *Ægilops ovata*, and replacing them with the anthers of *Triticum spelta barbatum*, the result of which was the production of a new hybrid, not one having the characters of the parent plant. From these results Dr. Godron arrives at the following conclusions:—1st, that hybrids may be obtained spontaneously from grasses, *Ægilops triticoides* being the first example known amongst them; 2ndly, that *Ægilops* and *Triticum* have not sufficiently distinguishing characters to separate them, and consequently must be considered as one and the same genus; 3rdly, that the conclusions of M. Fabre that the origin of wheat is to be traced to *Ægilops ovata*, or that one species can be transformed into the other, has not sufficient evidence to support it.

After such careful experiments and lucid reasoning from M. Fabre on the one hand and Dr. Godron on the other, many might be almost inclined to confess themselves converts to both opinions, though the arguments of M. Faber seem to us to have the greatest weight. We are continually having fresh proofs of the variation of species, and we know perfectly well what great changes are produced in plants by cultivation. We know, also, how distinct and numerous, even in wheat itself, the varieties are, and these distinctions are the effects of cultivation. Besides this we have abundant proofs of extraordinary changes and developments in nearly all our kitchen-garden plants. The potato, for instance, is one of the best examples of this, for, with all our fine and choice varieties, it is but the offspring of a small tuber having a bitter taste, a native of Chili and Peru. Our carrots, turnips, etc., in their wild state, are uninviting woody roots, and, in short, our gardens are filled with similar examples.

Having, therefore, so many proofs of the mutability of species, and the experiments of M. Fabre and Professor Buckman to help us, we look upon the theory of the origin of wheat

from *Ægilops ovata* as a very likely solution of the question. At the same time we would strongly recommend those who have doubts on the point to repeat the experiments for their own satisfaction, from which even now some fresh ideas might be had or knowledge obtained.

LUNAR PERSPECTIVE.

BY W. R. BIRT, F.R.A.S.

EVERY observer of the moon's disc is well acquainted with the apparent changes which the features undergo from time to time, especially those near the margin ; sometimes they appear close to the edge of the disc, and at others they are removed to a moderate distance from it, considerable alterations of form accompanying these oscillations of position. As these changes, both in position and form, depend upon the phenomenon known as the moon's libration, it may not be uninteresting if we attempt to explain the principles upon which they are effected.

The fundamental idea to be apprehended is simply this. At any given moment a line will join the centres of the earth and moon, and as both bodies are globular, this line will cut through a point in the surface of each. At the point on the earth's surface cut by this line let an observer be placed, and at the point on the moon's surface let there be a spot that can have the earth in its zenith. Rhæticus, which is situated on the moon's equator, is such a spot, and it is clear that, in the case suggested, Rhæticus and the observer will be respectively in each other's zenith, the crater occupying the middle of the moon's disc as seen from the earth. From this it will necessarily follow that the observer on the earth, looking through his telescope, directed to the zenith, will see the crater Rhæticus of nearly its *true* form, for the depth of the crater being very minute, as compared with the distance of the observer, perspective will scarcely interfere.

The perception of the true form of Rhæticus, with its interior shelving sides, will, however, be but momentary, viz., at the time of the moon's passing the meridian. While she is E. of the meridian the observer will see the interior E. slope *wider* than when looking directly into the crater at meridian passage, the interior W. slope being foreshortened. After meridian passage, the E. slope is foreshortened and the W. is viewed more directly, and from these phenomena it may be easily deduced that every object on the moon's surface under-

goes apparent changes of shape as well as position—within narrow limits—during the moon's passage above the horizon; and, near the margin, objects that were invisible at the time of the moon's rising, will be seen at the time of her setting. This phenomenon is called the diurnal libration.

The condition of Rhæticus being in the zenith of an observer on the earth, depends on the moon's passage of either the ascending or descending node, but as the passage of the node may occur with any degree of the moon's declination north or south, the observer who has had Rhæticus in his zenith in one lunation will not have it in the next; he may be either N. or S. of the point on the earth's surface cut by the line joining the centres of the earth and moon. In one case, the N. interior slope will be foreshortened; and in the other, the S. interior slope.

This foreshortening in a N. and S. direction will be augmented by the positions of observers on the earth's surface, in proportion as they are removed from the earth's equator. In high latitudes, and towards the poles, where the moon attains but a low altitude at meridian passage, the greatest foreshortening of lunar objects will be observed, especially in those regions which are removed farthest from the eye, in consequence of the inclination of the moon's equator to the plane of the earth's equator. From this it follows, that no two observers on the earth's surface will see any given lunar object of exactly the same form, or in exactly the same position on the disc.

The above-mentioned changes in form and position are slight compared with those that result from the inclination of the moon's orbit and axis to the ecliptic, combined with the varying velocity of her motion in her orbit. Bearing in mind that the line joining the centres of the earth and moon will cut different points of the surfaces of both bodies at different times, it is evident that a spot, such as Rhæticus, will have an oscillatory motion, or one allied to it, during every lunation, or interval from one new moon to the succeeding. It is when the moon is in either node that Rhæticus will be seen on a line dividing the apparent disc into two equal parts. As the moon moves N. of the ecliptic Rhæticus appears to move on the moon's disc towards the N., and the regions in the neighbourhood of the moon's south pole come into view, the result being that Rhæticus, with all the objects in the moon's N. hemisphere, are more foreshortened than at the time of the passage of the node, while those in the S. hemisphere are less, a few coming into such positions that they may be viewed in the zenith at meridian passage without foreshortening.

As soon as the moon has attained her greatest N. latitude she begins to return towards the ecliptic, and at the same time

the spots in the N. hemisphere commence their return to the equator of the apparent disc, becoming less and less foreshortened in their progress. After the moon has passed her descending node certain of the N. objects are seen on the S. part of the moon's disc; and they, with all the spots in the S. hemisphere, become more foreshortened until the greatest S. latitude is attained. At this time the regions about the S. pole, which were seen when the moon was in the opposite part of her orbit, are concealed, and corresponding regions in the neighbourhood of the moon's N. pole become visible. Upon the moon's return towards the ecliptic, with a motion from S. to N., all the objects on her surface partake of the same, the N. polar regions are gradually concealed, while the S. polar are as gradually brought into view. From these phenomena it follows that during the period that the moon's latitude is becoming more and more N., viz., from her greatest S. to her greatest N. latitude, the whole of the objects on her surface, visible to the earth, have a motion across her disc in the same direction, *i.e.*, from S. to N., some going out while others are coming into view, and during the period that her latitude is becoming more and more S., viz., from her greatest N. to her greatest S. latitude, the same objects have a motion from N. to S. This libratory motion is called the moon's libration in latitude, which may be rendered more intelligible by the annexed diagram (Fig. 1), in which E will represent the centre of the

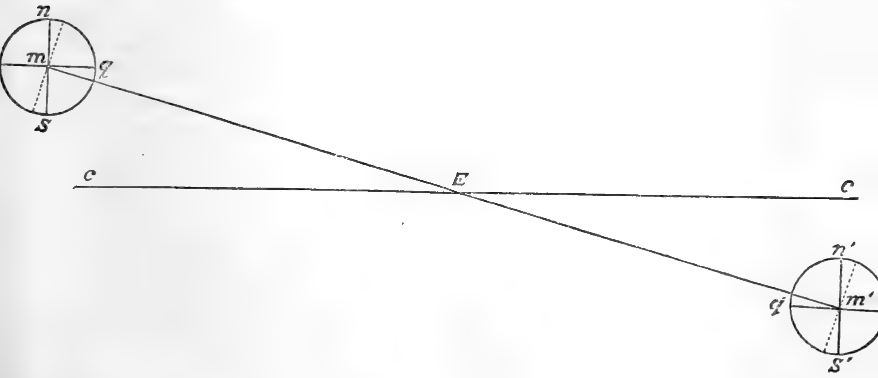


Fig. 1.

earth, n s the moon's N. and S. poles, q q the moon's equator, m E the line joining the centres at her greatest N. latitude, and c e c the ecliptic; the accented letters have the same signification when the moon is at her greatest S. latitude, the dotted line in each case represents half the boundary of the visible

disc by which the alternate visibility and concealment of the polar regions are rendered evident.

While the change of latitude produces an oscillation of the spots from N. to S. and *vice versa,* accompanied by alterations of form, the change of velocity of motion occasions a similar oscillation from W. to E. and the reverse. Popularly speaking, the moon always presents the same face to the earth, but as in one part of her orbit, that which is nearest to the earth, her motion is quickest, and in the opposite, that which is farthest, her motion is slowest, it is clear that unless the point on her surface cut by the line joining the centres of the earth and moon could accommodate itself to this varying velocity it must sometimes be to the W. and at others to the E. of a given point. Let the ellipse $p\ c\ a\ c'$ (Fig. 2) represent the moon's orbit; let o be the given point which will occupy the centre of the appa-

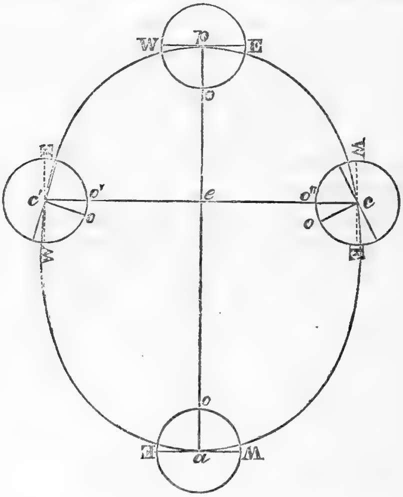


Fig. 2.

rent disc at the nearest (perigee) and farthest (apogee) distance of the moon from the earth; let $e\ o\ p$ and $e\ o\ a$ represent the line joining the centres of the earth and moon in each position, and let o' and o'' represent the points on the surface of the moon cut by the lines $e\ o'\ c'$ and $e\ o''\ c$ in two positions of the moon, one intermediate between apogee and perigee, the other intermediate between perigee and apogee. When the moon is beginning to move quicker than the mean motion, the point o is W. of the centre o' of the apparent disc W. $o\ o'$ E, but as she comes up to perigee the point o is gradually transferred towards the E., and occupies the centre of the apparent disc, at the time of perigee when the motion is quickest; but while it

continues *quicker* than the mean, the point *o* is transferred still further towards the E., arriving at its limit when the moon's motion begins to be slower than the mean, after which the motion of the point *o* is towards the W., occupying the centre of the visible disc at the time of apogee, and proceeding still further W. until the motion is beginning to be quicker than the mean. It is to be noted that the *regularity* now described is greatly interfered with by the libration in latitude.

That which is true of one point on the surface is true of every other, so that all objects partake of this change, moving E. during the period the moon is moving quicker, and moving W. while she is moving slower than her mean motion, and from this it follows that during the period of her quicker motion certain objects near her E. margin are concealed, while other objects near her W. margin are brought into view. On the other hand, while passing through the slower part of her orbit objects near the E. margin come into view while those near the W. are gradually concealed. These changes of position, which are accompanied by changes of form arising from a greater or less foreshortening, constitute the phenomenon called libration in longitude.

As general results of the libration in latitude and longitude it may be briefly stated—

First. That when the moon is in perigee or apogee at the passage of either node the apparent disc is in a state of mean libration, for the line joining the centres of the earth and moon cuts the moon's equator in the point which is equidistant from the W. and E. limits of change of position arising from libration in longitude. It is from the line at right-angles to the equator (the first meridian) that the longitudes of lunar objects are reckoned. In consequence of the inequality of the motion of the nodes, and that of the line *p o e o a* joining the perigean and apogean points (the line of the apsides), a state of mean libration can only occur once in three years.

Second. That when the moon has N. latitude all the objects on her visible surface are N. of their *mean*, or normal positions, and that when she has S. latitude they are S. of these positions.

Third. That while the moon is moving from apogee to perigee all objects on her visible surface are W. of their normal positions, and that while she is moving from perigee to apogee they are E. of these positions.

It may from these data be easy, by means of lunar maps, and taking from the *Nautical Almanack*, for any given time, her latitude, and the sides of her orbit, to form a tolerable idea of the apparent surface as to the proximity to the margin, or otherwise, of the most salient features.

In applying the above-mentioned principles and phenomena

to the illustration of lunar perspective, it is essential to change the line joining the centres of the earth and moon, for one joining the eye of the observer and the moon's centre. It is clear that in this, as in the former case, the point on the moon's surface cut by this line will be the centre of the apparent disc, and here it may be proper to remark that the numerical expressions of the values of the libration of the apparent disc in latitude and longitude have reference *only* to the centre of the apparent disc, as seen from a given point on the earth's surface at a given time. These expressions are simply the latitude and longitude of this centre—thus, if the libration in latitude be equal to 3° N. and that in longitude to 2° W., the meaning is that the centre of the apparent disc is 3° N. of the equator, and 2° W. of the first meridian—the equator being S. of its normal position and the first meridian E.

Returning to the consideration of perspective. The smallest amount of foreshortening takes place at the centre of the disc, and as the observer is looking upon a globe, the foreshortening rapidly increases towards the margin in every direction. Lunar objects are of all conceivable shapes and sizes, from the extensive *Maria* to the smallest discernible hillocks and pits. They will, however, undergo apparent changes of form and position, in accordance with well recognized laws. Most objects of any size will—as they are found near to or removed from the margin—be presented to the eye under elliptical forms, generally of great irregularity, all the shorter axes being directed towards the centre, and all the longer axes being portions of curves more or less concentric with the margin. In consequence of the inequality of the moon's motions, above-mentioned, the approach and recess of the spots towards and from the margin are very irregular, bringing prominently into view at some seasons certain features, and at others concealing them; thus it arises that no two drawings of a lunar object at different epochs, by the same observer, or by two observers, even at the same epoch, agree fully in detail. It is true that an experienced eye will detect manifest errors, but with the most assiduous attention capable of producing the most scrupulous accuracy, differences must occur as the results of differing perspective. This is very evident from an inspection of a collection of photographs taken at different states of libration. The well-known elliptical spot the *Mare Crisium* is seen, when the moon is moving from apogee to perigee, to approach somewhat closely to the margin, the surface in the direction of the shorter axis being much contracted, and in a particular position the N. boundary appears as a *straight* line of mountains. During the period when the moon moves from perigee to apogee the *Mare Crisium* attains its greatest distance from the margin, the finely

variegated surface is brought more directly under the eye, many objects become visible that could not be seen when, by its proximity to the margin, it was greatly foreshortened. The N. boundary presents a very different appearance, being both curved and indented by numerous bays and valleys; indeed, representations of this interesting region at the two extreme epochs differ amazingly from each other. It is curious to notice the remarkable and totally unexpected changes in form that many spots present under these extreme conditions, and when watched from night to night, and from season to season, the gradations of change are highly interesting. As instances we give two drawings of the well-known walled plain "Plato," affected considerably by libration in latitude.

The engravings represent the Lunar Crater Plato, as seen under two different states of libration. The drawing of Fig. 3

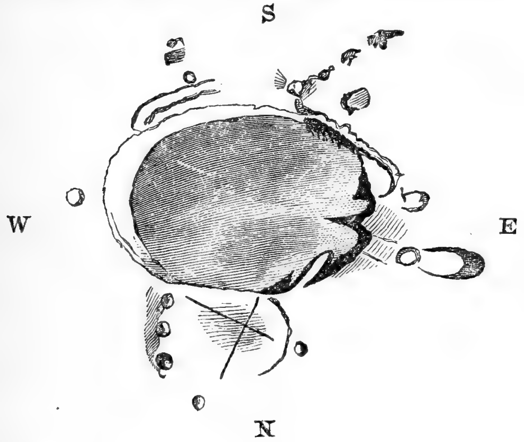


Fig. 3.

was made in 1863, at Hartwell, on January 11, between 13 and 19 hours, G.M.T. The telescope used was the equatorial of 5·9 inches aperture, powers 118 and 240. At the time the drawing was made, Plato was under the evening illumination, the moon having attained her greatest libration, the quadrant in which the greatest change was observed being the S.E. At this time the moon's latitude was about 4°·50′ *South*, bringing Plato nearer to the eye of the observer, so that the elliptic form of the crater was *widened*, all objects being south and west of their mean places. The prominent features in the drawing are—1st. The bright interior of the west wall of Plato. 2nd. The indented shadow of the east wall. 3rd. A formation on the north of Plato, bounded on the west by a mountain range. On the surface of this formation are two rills crossing

each other. 4th. On the S.W. of Plato is a mountain range projecting from the mountainous border of the crater. This mountain range is the *highest* in the immediate neighbourhood, its shadow being the *last* to be observed on the surface *outside* the S.W. rim of Plato.

The drawing of Fig. 4 was made in 1863, at London, on

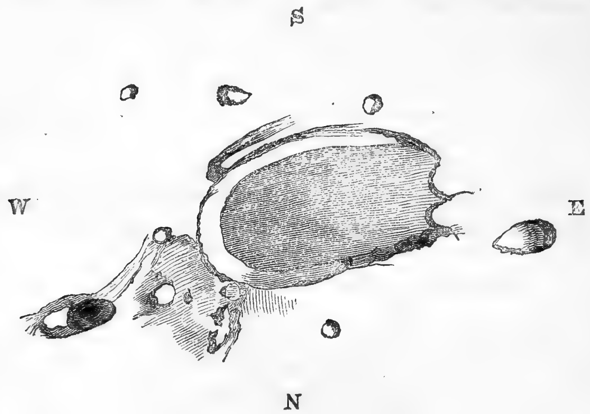


Fig. 4.

July 6, 13 to 15 hours, G.M.T. The telescope used was the Royal Astronomical Society's Sheepshank's, No. 5, aperture 2·75 inches, power 150. This drawing is also under the evening illumination, but the moon had not attained her greatest libration; nevertheless, objects were north and east of their mean places. The moon's latitude was about 4°·40′ *North,* so that Plato was removed further from the eye, and consequently its elliptic form was *narrowed.* The libration in longitude having carried objects further east, Fig. 2 is differently circumstanced to Fig. 1. The prominent features in Fig. 1 are, however, well recognized in Fig. 2. 1st. The bright interior of the W. and S.W. wall, but rather *differently* illuminated. 2nd. The indented shadow of the E. wall. This feature presents a great difference in the two drawings—the crag, or tongue, which projects inwards from the N.E. in a S.E. direction in Fig. 1 is wanting in Fig. 2, and the shadows are not so broad, the difference between the epoch of observation, and that of sunset, being greater in Fig. 2 than in Fig. 1. 3rd. The formation on the north was not drawn, except the mountain range forming its west border, which, in Fig. 2, is *straight,* instead of being *curved,* as in Fig. 1. A few objects are given in Fig. 2 on the N.W. not in Fig. 1. Of these, the north edge of Plato, the mountain and crater in a line with it, and the south edge of the crater on the east, were ascertained to be

in the same line. 4th. The mountain range on the S.W. presents the same character in both drawings.

The cardinal points are only approximately placed to indicate the general position of the crater and the surrounding objects, and are not to be taken as showing the true bearings. The crater on the N.W., the ϕ of Schröter, is remarkable. On several occasions I have observed a dark nebulosity surrounding a dark spot in the middle of the shadow. I am not certain of the precise nature of the crater.

RED STAR.—DOUBLE STARS.—NEBULÆ.—LINNÉ AND ARISTOTELES.—OCCULTATIONS.

BY THE REV. T. W. WEBB, A.M., F.R.A.S.

It is now many years since, in consequence of a statement that a red star, of remarkable beauty and intensity, was to be found *f* α in *Hydra*, I searched that region repeatedly in vain. I was subsequently informed that my *pointer* should have been designated α *Hydræ et Crateris* (better, surely, α *Crateris* alone, for there is no other *Crater*, and *Hydra* is of itself more than sufficiently extensive). The region being now in sight at a convenient hour, I determined upon a search with my beautifully-defining $9\frac{1}{4}$ inch "With" speculum, during one of the very few evenings (March 27) which have admitted of the employment of a telescope during many weeks. The position of *Crater*, near the meridian, was easily made out, as a group not many degrees above the horizon, preceding the four conspicuous stars of *Corvus*, which in turn precede, though at a much lower elevation, the brilliant *Spica*. It composes a long and rather narrow trapezium, extended E. and W., and formed by two unequal lines, of two stars each, the lower line being shorter than the upper at its W. end. The star, whose displacement towards the left, so to speak, turns into a trapezium what would have been a parallelogram, is the α in question. But it certainly does not deserve that appellation. Of the four stars (as far as a rapid comparison enables me to speak) the brightest was the uppermost to the W.; this, however, though included in *Crater* in the larger maps of the S.D.U.K., and marked there with Flamsteed's figure 4, as belonging to that asterism, is referred by Argelander, one of the highest authorities, to *Hydra:* but the 2nd in the upper line, δ *Crateris*, is much superior to α, and γ, to the left below, about equal to it. It has been shown that Bayer, whose Greek designation

of the stars was published in 1603, was guided in some cases by position, as in others by magnitude, and this enfeebles the presumption of variable light which would otherwise arise in many constellations: and, in the present instance, a certainly stands first in R.A., among the lettered stars of *Crater;* still, had it been then as inferior to δ as it is now, it seems hardly likely that he would have so distinguished it. In the adjacent *Hydra* he has evidently had the order of brightness in view. In the S.D.U.K. map, δ has 3rd, a and γ, with ν *Hydræ,* 4 mag. Argelander gives ν *Hydræ* and δ 3·4, a and γ, 4 mag. It seems desirable that variable light should be looked for here: a may have diminished, or δ increased, or both.

Having found a *Crateris,* we let him pass through the field, and we shall find him followed, at 42·5s, 1′*s,* by his ruddy attendant, whose hue is certainly very striking, and much resembling that of our acquaintance R *Leonis* (see our March number). It is, however, small enough to require a fair aperture to exhibit its colour well. Baxendell has found it variable, considering it, April, 1866, fully $\frac{3}{4}$ mag. smaller than during the spring of 1865: and hence he has designated it, according to Argelander's system, as R *Crateris* (implying that it is the first variable discovered in that constellation, the letter S being reserved for the next, and so on). At a short distance from the red star, and on a line pointing but a little *s* of a, there is a somewhat smaller one, which I found of a decidedly blue tint. It would be interesting to ascertain whether its hue was the effect of contrast; but this would be better done with a very large aperture, and the contracted field of a Dawes' eye-piece; my impression certainly was that it was blue rather than green, the complementary tint; and that its colour was, therefore, in part at least, independent. No time should be lost in looking for this group, now rapidly passing away.

It has been repeatedly remarked that a ruddy tinge is often associated with variable light. Such is eminently the case with R *Leporis* and R *Leonis,* to which may be added another remarkable instance, R *Cassiopeæ,* which, according to Pogson, is vividly red. It lies in R.A. xxiiih. 51m. D.N. 50° 35′, and varies, according to Professor Schönfeld, somewhat uncertainly as to brightness, sometimes rising to 4·8, at others only to 6 mag.: the period also may be shortening, as before 1865 he thought it had been 449 d., but in that year it appeared to be 430 d.; and at its next return, 412·5 d. From the two previous *maxima,* 1865, Feb., 21·5; 1866, Apr. 10, the next may be expected to occur between May 7 and May 10, on the supposition of an equable acceleration. This, however, is most improbable, as the period would thus, in a few years, become = 0, instead of being expressed, like all similar alternations, by an undula-

ting curve of more or less regularity. We shall, therefore, expect to find that the *maximum* will be retarded beyond this epoch, though it may probably fall within the month. If the acceleration has reached its limit for the present, it will take place about May 27 or 28; but in the existing absence of more reliable data, it should be watched from the 7th to the end of May.

The present may be an appropriate place for introducing the mention of two *Red Stars* not included in Dr. Schjellerup's catalogue of those objects, in No. 1591 of the *Astronomische Nachrichten*, or in the list given in our number for Sept. last. Mr. Lassell states, in the *Monthly Notices*, xvii., 65, that on Sept. 5, 1857, while sweeping about Cygnus, with his 2f. mirror, and admiring, with power 160, the wonderful richness and splendour of the milky way, he discovered what appeared to him the deepest red star he had ever seen, 9½ mag. R. A. xxih. 16·6m., N.P.D. 48° 13′: while in R.A. xxih. 37m., N.P.D. 52° 42′ is another deep-red star, rather brighter, 8 mag.

DOUBLE STARS.

The acquaintance we have made with ν *Hydræ* will enable us by his means to fish out two objects in the same neighbourhood, which, though telescopic, being easily found, may be admitted into our long discontinued list of Double Stars. Resuming our former arrangement, the first will stand as

158. P. x. 159 *Hydræ*, 31″5. 10°. 8, 9. Pale white and light blue; less than 1° *n p* ν *Hydræ*. This pair, though pretty, points, nearly, to a much finer object, about 22′ *n*;

159. Σ 1474 *Hydræ;* a beautiful triple group, of which the data, according to Σ, are: A. 6·9, B. 8, C. 7·7 mag.—A.B. 71″67, 22°22.—C.B. 6″38, 196°14.—Very white.

NEBULÆ.

In our number for last November, mention was made of certain nebulæ to which a suspicion was attached of variable light. In Rümker's *Hamburg Catalogue of Circumpolar Nebulæ*, recently completed, two more instances occur, which may with propriety be included in our list of these objects; since, having been observed with only a 5f. telescope, they are within the reach of a large proportion of astronomical students. The first is (resuming our own numbering):—

33. Gen. Cat. 4351. R.A. xvii h. 50m. 54s., D.N. 70° 10′ 48″. Of this, which was discovered by Auwers 1854, July 24, and considered by him pretty faint, Rümker made four observations, 1866, Oct. 5, 6, 7, 11; in the three first of which it is expressly called "bright," or "very bright." It

is 3—4′ long, 1′ broad, and with a darkness in the middle, so as to convert it into a double nebula, of which the *n p* portion is the brighter, and the axis inclined 20° to the parallel. The other nebula is:

34. Gen. Cat. 4415. R.A. xviii h. 23m. 35s. D.N. 71° 30′ 12″. Discovered by Tuttle (America) 1859, Sept. 1. The possibility of variation here had already been pointed out by H. on a ground repeated by Rümker, namely, that D'Arrest had seen it in a comet-finder, 1862, Sept. 24, so large and so bright, that in a similar condition it could not have escaped M., Ḫ., or H. When we bear in mind the insufficiency of M.'s optical means, which led him to assure himself that the glorious nebula in Hercules contained *no stars*, the brightness, in 1862, of an object which, in the opinion of so great an authority as D'Arrest, could not have escaped his notice, is very striking. We must not, however, forget that the great light and expanded field of a comet-finder would give it a very different aspect. When observed by Rümker, 1866, Oct. 4, 5, 6, 7, it was entered as pretty faint, or only moderately bright, and he remarks that, in the field of an ordinary comet-finder, it would have been seen with great difficulty, or only in consequence of its juxtaposition with two 11 mag. stars *p.* at a short distance. It would be an interesting object of study.

To these we shall add two others, not very distant from the region of our red star, which we must look for with little delay, in consequence of their small meridian altitude and the advancing season.

35. *The Gaseous Nebula in Hydra.* Gen. Cat. 2102. Ḫ. iv. 27. Sm. describes this as a pale, greyish-white, planetary nebula, resembling Jupiter in size, equable light (not, of course, *brilliancy*) and colour, with four telescopic stars surrounding it, a line between those *np* and *sf* touching the disc—a not unimportant remark, from the suspicions which have been entertained of the possibility, either of satellite-stars, or proper motion in nebulous masses. H., who includes it as No. 3248 in his S. catalogue, says it extends about 30″ by 25″, and is of a very bright, uniform light, and very decided pale blue colour, but not quite sharp at the edges. In 1851, with an aperture of $3\frac{7}{10}$-inches, I found it a very bright and beautiful object, so small with 64 that it might be overlooked in sweeping, but bearing increase of power wonderfully up to 250; the elliptical form, the haziness of the limb, and the blue tint, were all independently noticed; which is simply worthy of mention as an encouragement to the possessors of the smaller class of instruments. I now see it (1867, April 9) with the $9\frac{1}{4}$-inch mirror, as a very brilliant object; and the effect of increase of aperture is strikingly exemplified in its

enlarged diameter with the same power; it could not possibly be overlooked here by any imaginable amount of carelessness. It is, however, very probable that this effect is due in part to a greater decrease of light towards the edge than would be made sensible in any other way. It is singular how little power the most delicate vision has of detecting, at least under certain circumstances, gradual variations in brightness. This is undeniably and curiously exhibited in the case of Jupiter, whose disc, sensibly uniform in brilliancy, is shown to be much more brilliant in the centre by the frequent change in the aspect of the satellites during their transits. It is also exemplified in the telescopic discs of stars, which are known, from theory, to degrade rapidly in light from the centre, though this is only manifested to the eye by the different sizes of the discs in proportion to their luminosity. And it is more than probable that the uniformity of light ascribed by Sm. to this nebula and Jupiter is as illusive in the one instance as in the other. With this large aperture the edges were extremely woolly; the elliptic form and blue tint were not conspicuous, but there was some moonlight, and, probably, haze, and the meridian was long passed. With 170 and about 600, I fancied the light not very equable; but I was aware that Secchi had broken up the supposed uniformity of aspect: not in consequence of greater light, having only $9\frac{6}{10}$-in. achrom. against $18\frac{1}{4}$-in. front view reflection, but from higher power; H.'s 180 being the most suitable for his purpose of surveying the whole heavens; while Secchi, having a special design, was able to carry his even up to 1000 with great distinctness, and thus he perceived, within a circular nebulosity, two clusters connected by two semicircular arcs of stars into one sparkling ring, with a single star upon the hazy central area. Yet, as in the case of the annular nebula in Lyra, the appearance must have been deceptive, at least as to the existence of matter in a solid or even a liquid state. At such a distance the eye can take no direct cognizance of the nature of what it sees; but the prismatic analysis of light will still give information which, though indirectly obtained, seems fully to be trusted; and in this way Huggins, through his 8-in. object-glass, with powers of 600 and 920, detects the oval ring, which he thinks is seen obliquely by us within a globular mass of faint nebulosity, yet finds, from the quality of its light, decomposed into three bright lines, that it consists almost entirely of gaseous matter. With a wider opening of the spectroscope than would define the lines properly, he "*suspected* a faint and broad continuous spectrum," indicating the presence of some feebly luminous solid or fluid materials (or possibly small stars involved in the mass?). We have here evidently a structure not very dissi-

milar to that of the annular nebula in Lyra. To find it, we must run a line through the stars δ *Crateris* and ν *Hydræ* already described, bending it a little upwards; this will point out, at nearly an equal distance, μ *Hydræ*, a 4 mag. star of a glorious yellow hue, about 2° *s.* of which the nebula lies.

We shall find a curious contrast to this marvellous object in our next, which, however, will require a very transparent night, from its nearness to the horizon.

36. Gen. Cat. 3128. M 68. This Sm. calls a large, very pale, mottled nebula, 3′ × 4′ diam. H. describes it at the Cape at a much greater elevation, as an irregularly round cluster, gradually brighter in the middle, very ragged at the borders, all clearly resolved into 12 mag. stars. To me, with $3\frac{7}{10}$ inches, it was a rather faint, but, from its size, pretty conspicuous object, not bearing magnifying. A line will find it, run nearly vertically down through δ and β, the two bright *f* stars of *Corvus*. At about half their distance, it will point out a 5 mag. star, closely *n f*, which is the nebula.

The apprehension we expressed some time ago, that the light of the *Great Spiral Nebula*, M 51, No. 29 (INTELLECTUAL OBSERVER, viii., 209) would be too feeble for prismatic analysis, has not been realized, Huggins having found the spectrum of each nucleus continuous, though with a suspicion that some parts were abnormally bright. Hence the stellar constitution ascribed to this marvellous system by the E. of Rosse seems verified. Apr. 11, intending to look for it, I came suddenly upon another object, at no great distance, which I took at first for a telescopic comet, but afterwards identified, and which may stand as—

37. Gen. Cat. 3474. M 63. R.A. xiii h. 9m. 32s. D.N. 42° 46′ 15″. Discovered by Mechain, 1779. Described by Sm. as an oval, milky-white nebula, with a nucleus like a small star. H̥ found it very bright, 9′ or 10′ long by 4′ broad, with a very brilliant nucleus, which H. speaks of as almost stellar. It appeared quite so to me, about 10 mag. ? (Σ) but I used no higher power than 239: with 65 and 111 I might have overlooked it. The nebula lies between a 7·5 ? mag. star *p*, and an interesting but very minute triplet 9·5 ? mag. *f*. It may be found by sweeping in a barren space, about half way between the last star of the Great Bear's tail, and *Cor Caroli*. Three nebulæ in *Scorpio* will repay our search, but we must watch for opportunities—long days, moon-light, and nearness to the horizon, being all against us. We take first—

38. Gen. Cat. 4183. M 4. This, according to Sm., is a compressed mass of very small stars, with outliers; elongated, and blazing in the centre; with a ridge of 8 or 10 pretty bright stars, running *n f* from the middle. We find it readily about

$1\frac{1}{4}°$ *p Antares*, a large but rather dim object. Sm. remarks that it stands on the W. edge of a starless area. Our next is—

39. Gen. Cat. 4173. M 80. Sm. calls it a compressed globular cluster of very minute stars; a fine bright object with a blazing centre, like a comet.* H̥ styled it the richest and most condensed mass in the heavens. It was all resolved by H., at the Cape, into 14 and 15 mag. stars. A wonderful instance in itself of the mysterious arrangements of creative power, but deriving its chief interest from the fact that in the same position is a marvellous variable star. Neither M., H̥, H., Sm., Argelander, nor D'Arrest, had noted anything unusual here. Auwers, the well-known observer of nebulæ, had often seen this cluster in its ordinary aspect, in the spring of 1859, and even as late as 1860, May 18. By May 21, with a rapidity analogous to that of the variable in *Corona Borealis* (1866, May 12), or that of the Great Star of 1572, there had broken out in the place of the cluster a bright telescopic star, according to Auwers of 7, to Luther of 6·5 mag. It was the same the following night; by the 25th both found it rather smaller; and Pogson saw it of 7 or 8 mag. on the 28th. June 10, Pogson had lost it; but thought the cluster unusually brilliant and condensed. Auwers did not quite lose sight of it, and perceived that it was not central. It is barely conceivable that such an outburst should take place in the heart of a cluster, and leave it as before; and it is more natural to suppose that the objects are merely optically coincident; but the progress of discovery may well teach us caution in our deductions. In the same field with this cluster, *f*, a little *n*, are two undoubted variables, R and S *Scorpii*, discovered by Chacornac in 1853 and 1854, changing from about 9 to less than 14 mag., or invisibility; the former with a probable period of about 648; the latter, $364\frac{1}{2}$d. Baxendell's remark, that these marvellous objects are apt to occur in groups, is strikingly exemplified here.

We shall readily find this cluster half way between *Antares* and *β Scorpii*, 2 mag., the brightest star of the group *n p Antares*.

40. Gen. Cat. 4261. M 62. Sm. calls this a fine large resolvable nebula, running up to a central blaze. H., at the Cape, who terms it superb, resolved it all into 14—16 mag. stars. We may find it from *δ Scorpii*, 3 mag., the most *s* star of the group *n p Antares*, by running a line back to *Antares*,

* The assertion of this usually most accurate astronomer, that it lies on the W. edge of a vast obscure opening without stars, 4° broad, may, perhaps, have arisen from some confusion with its neighbour, M 4. On two occasions I have seen, with only $3\frac{7}{10}$ inches, many minute stars E. of it.

and carrying it on about an equal distance. It is, however, very low in our latitudes.

LINNÉ AND ARISTOTELES.

The evening of April 11 proving an exceptionally fine one during a most unfavourable season, I determined to examine the site of *Linné,* although considerably removed from the terminator, near which I have never yet had an opportunity of looking for it. The quadrature had taken place at 3h., and at 7h. 15m. (G.M.T.) the terminator bisected the ring of *Aristillus,* while the greater part of that of *Autolycus* was tipped with light. With my 9¼in. silvered speculum, and powers of 212, and the same raised considerably by a Barlow lens, I found the general definition something better than usual, but varied by short though frequently recurring intervals of great distinctness. It was not difficult to see that there was some marking in the white, ill-defined patch on the site of Linné; but its nature was not so readily made out. With close attention, I once or twice thought I saw the "ghost" described by Mr. Knott (*Astron. Register,* L. 33) as a pale ring, about as large, perhaps, as that figured by B. and M., a little brighter than the included or exterior surface. But this was seldom the case, and what was much more frequently and steadily seen was, not merely the black point described by Schmidt, but its character as the shadow in a very small crater, surrounded by a luminous ring of considerable proportional breadth. It seemed not more than $\frac{1}{3}$ as large as the nearest little crater to the N.W., *Linné* A of B. and M.—7h. 45m. Air not quite so good: power about 239: previous observation confirmed. The "ghost" ring and the minute crater cannot be seen both at once; but I think the pit lies at the W. side of the ring: this, however, is quite doubtful. It may be half the size of *Linné* A.—8h. 15m. Air worse; but once a pretty clear though transient view of the little crater. This result, under the circumstances, ought only to be received with caution: I would, however, record my full impression that the minute pit and its ring have an actual existence. It will be seen that the observation is in full accordance with that of Secchi, and differs somewhat from those of Schmidt; owing, it may be presumed, to the superiority of my powerful reflector, whose definition probably resembles more nearly that of the celebrated Roman achromatic, than that of the tarnished dialyte with which, nevertheless, so much admirable work has been done at Athens. But all results tend to establish the reality of Schmidt's claim, as the discoverer of an unquestionable instance of lunar change.

Such events will naturally lead to a closer scrutiny of minute

features. On the same evening, I found the crater on the summit of the western Γ, near *Aristoteles* (see the diagram in our Jan. number), extremely obvious, and the hill itself apparently not more than half as high as its neighbour, and casting much less shadow: the W. height of the group of three hills and three craters N. of Γ has also a shallow crater upon its summit; and the "irregularity" mentioned at that time in the crater B, is found to arise from a ring formed by a subsequent eruption in its interior; a very unusual feature in a crater of this size. At moments of best definition, the mountains exhibit plainly, in many places, the rough and spongy character ascribed to them by Chacornac, and the N. slope of *Aristoteles* is studded in many places with very minute craters, never seen before.

OCCULTATIONS.

The astronomical May 1st is remarkable for the occultations of the two planets Venus and Mercury; the latter of which, however, according to civil reckoning, falls on the 2nd. The dates are, Venus, 1h. 15m. to 2h. 20m.; Mercury, 22h. 53m. to 23h. 46m. Both being in broad daylight and near the sun, an equatorial mounting is necessary.—6th. 117 Tauri, 6 mag., 8h. 4m. to 8h. 41m.—17th. o^2 Libræ, 6 mag., 11h. 57m. to 12h. 59m.

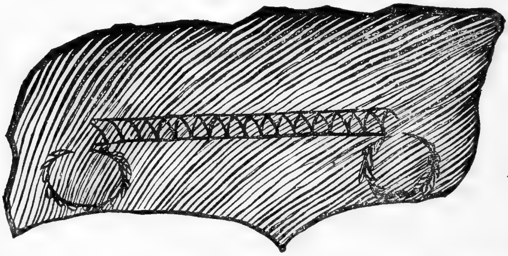
GRAPTOLITES: THEIR STRUCTURE AND SYSTEMATIC POSITION.

BY WILLIAM CARRUTHERS, F.L.S.

Name. The name *Graptolithus* was first employed by Linnæus, in the original folio edition of his famous *Systema Naturæ* (1736), for certain natural objects, which he describes as resembling, but not being, true petrifactions. He included in this generic group ruin marble, dendrites, and fucoid and worm markings, but not a single form of the fossils to which the name is now confined. No change is introduced into the genus until the publication of the twelfth edition of the *Systema* in 1767. The thin folio* of the first edition, with its twelve pages, had been gradually increasing in the various

* The Stockholm Academy have resolved to reproduce this rare volume by photo-zincography, so that ere long it is to be hoped that the possession of a fac-simile of Linnæus's great work may be within the reach of every student of nature.

authorized editions, until in this, the last edited by Linnæus himself, it appeared in three octavo volumes, containing altogether 1504 pages. It is curious to look at the classification of fossils contained in this work, and notice how the science of Palæontology has grown during the century that has elapsed since the death of the famous Swede. Every known *true* fossil (in the modern use of the term) was classed under one or other of seven genera, depending upon whether it belonged to a (1) mammal, (2) bird, (3) reptile, (4) fish, (5) insect, (6) worm, or (7) plant. The genus *Graptolithus* was retained for a number of anomalous and puzzling bodies, which were, "properly speaking, not true fossils, though they were popularly referred to fossils." Of the seven species included in the genus in the first edition, two are here omitted (star-stones and stigmites), and three others are added; but of the eight species only *one* is a true graptolite. This he named *G. scalaris,* and the illustration and description on the 147th page of his *Scanian Travels* (1751) are quoted for it. As this is the first figure of a graptolite, we reproduce it here in fac-simile, and translate his short description. He says,



Fac-simile of the Figure of *Graptolithus scalaris*, Linn. From *Skanska Resa*, p. 147.

"Petrifaction or graptolitus of a curious kind, found in a slab of slate that had been broken to pieces, the black characters of which, upon the grey stone, resembled a line such as might be printed by a coin on its edge, and often terminate in spiral ends." This drawing and description have been very differently interpreted, and it is an interesting inquiry to ascertain what Linnæus meant by his original species. The spiral ends have certainly no connection with the linear fossil, but belong to a different species, most probably *G. convolutus,* His. All are agreed that the figure represents a graptolite preserved so as to show the cell mouths on its upper surface, and from this, specimens thus preserved have been called "scalariform impressions." Some hold that it belongs to a species with a single series of cells, but I believe that Hall more correctly

refers it to the group with a double series of cells. The figure is too broad for a species of *Graptolithus,* and the length and general aspect agree better with Diplograpsus, so that I do not hesitate, with Hall, to refer it to that genus. Moreover, Hisinger's *Graptolithus* (*Prionotus*) *scalaris,* collected in the same locality as that in which Linnæus obtained his fossil, is undoubtedly the species that was afterwards described by M'Coy under the name of *Diplograpsus rectangularis.*

Graptolithus sagittarius, of the twelfth edition of the *Systema,* has always been quoted as belonging to this tribe of fossils. I cannot imagine how Hisinger came to apply this name to a species of the restricted genus *Graptolithus,* with which Linnæus's description has not one character in common. The original species was founded on the drawing of the fragment of a *Lepidodendron,* a genus of fossil coal plants, in Volkmann's *Silesia subterranea* (1720), Part III., Tab. 4, Fig. 6, which is accurately described in the short diagnosis appended by Linnæus to his species. This error made by Hisinger has passed through all the works on Graptolites uncorrected, and has caused the Linnean generic name to be applied to the species with one series of cells, whereas the only species known to Linnæus was a Diplograpsus.

We would here object to a practice that has prevailed among some writers on this family of fossils of altering the spelling of generic names to suit their peculiar notions. Unless under very peculiar circumstances, the original spelling should always be retained, and as Linnæus wrote the generic name, *Graptolithus,* it ought to be so used. In his *Scanian Travels,* it appears as *Graptolitus,* but in the *Systema* he retains throughout the original spelling. The term Graptolites may be considered to be a useful English form of the word, and may be conveniently employed, as it has been by Barrande, as a common term for the whole family.

Structure. Believing, with the majority of those who have examined this family, that the graptolites are true Hydrozoa, I shall discard the nomenclature that has crept into use, adopted, as it has been sometimes, from supposed resemblances to plants, and sometimes from affinities to animals, and employ the terms that have been proposed by Huxley and Allmann, in their works on the recent Hydrozoa. As these terms have not yet got into general use, it will enable the reader better to follow the descriptions if I here give definitions of the few that it will be necessary to employ. The observations made within the last twenty years on the Hydrozoa, have shown that every hydroid exists under two separate forms, the one, the "trophosome," destined only for nutrition and growth; the other, the "gonosome," designed for the

reproduction of the species. The trophosome consists of a chitinous "polypary" that invests the "cœnosarc," or common connecting fleshy basis of the colony, as well as the individual "polypites," which are, in some tribes, protected by a specially developed receptacle, or "hydrotheca." The "hydrorhiza" is the root-like proximal termination of the polypary, by which the hydroid is attached to foreign bodies, and the "hydrocaulus" is the portion of the polypary that intervenes between the hydrorhiza and the polypites. In the *Sertulariadæ*, the "gonophores," or generative buds, are produced in a capsule, called the "gonangium."

The trophosome is the only form of the graptolite with which we are acquainted. Its polypary was composed of a flexible chitinous substance, like that of the recent hydroids. It is preserved either as a thin carbonaceous film between the layers of a fissile shale, which, on being split, presents an equally perfect impression on both surfaces, or second in the round in the same shale, when the whole organism is converted into iron pyrites, or third in limestone, where the fossil frequently retains its original form; and while the polypary is converted into a carbonaceous substance, the interior, originally occupied by the cœnosarc and polypites, is filled with the amorphous substance of the rock. I have made several sections of two species (*G. priodon*, Bronn, and *G. Roemeri*, Barr.), preserved in the round in limestone from Bohemia, and have also examined specimens of *G. Sedgewickii*, Portl., and *G. convolutus*, His., from the Moffat shales, retaining their natural form; and though the pyrites is more unmanageable than the limestone, I have determined that they all agree in structure. M. Barrande has accurately described the structure of the Bohemian species named. *G. priodon* (Plate, Fig. 1) is composed of a single series of hydrothecæ, the walls of which are in conjunction for nearly two-thirds their length, but the outer portion is free. In the longitudinal section (Fig. 15), the relation of the hydrothecæ to each other is more obvious. M. Barrande figures the separating walls as double, and though they must be so, I have not been able to detect, even with a high magnifying power, more than a single thin layer. In the process of fossillisation, all traces of the two walls have disappeared in the specimens I have examined, but its double nature is seen when, towards the mouth of the cell, it separates into two portions, the one to form part of the superior hydrotheca, and the other of the inferior. A free space exists between the base of the hydrotheca and the wall of the polypary, which was filled with the cœnosarc of the colony. This is the common canal of M. Barrande. There is no constriction, or septum, at the base of the hydrotheca, separating the indi-

vidual polypite from the common cœnosarc. M. Barrande describes an internal orifice as existing in this position, but his longitudinal section of *G. priodon* gives no indication of it, and his figures illustrating it in *G. nuntius*, Barr., and *G. Halli*, Barr., show that he has been misled by referring to these species scalariform impressions of a double graptolite. His internal orifices are the external openings of the under surface, showing themselves faintly through the chitinous investment of the polypary, while the external orifices are the series of openings preserved on the upper surface, which are consequently preserved with greater definition.

The back of the polypary was strengthened by a solid axis (Fig. 2) composed of the same substance as its walls. This is a distinct structure, and capable of being separated from the graptolite without destroying that surface to which it is closely applied. It is frequently continued beyond the cell-bearing portion of the graptolite as a simple naked axis.

The structure of *G. Roemeri* (Fig. 16) agrees in every respect with that of *G. priodon*, except that the walls of the neighbouring hydrothecæ are in contact throughout their whole length. In this respect there is a considerable variation among graptolites. In *G. convolutus*, His. (Fig. 14), the hydrothecæ are free throughout their whole length, while in Barrande's genus, *Rastrites* (Fig. 17), the individual hydrothecæ are not only free, but separated from each other by an interposed non-polypiferous portion of the filiform polypary. A very different structure appears to exist in *G. latus*, M'Coy, and *G. sagittarius*, His. Both these species have as yet, I believe, been found only in a flattened condition, so that the full meaning of the external appearances cannot be positively determined. In well-preserved specimens of both, there seems to be a septum at the base of each hydrotheca; and in *G. sagittarius*, I have noticed the divisions between the individual polypites passing down to the solid axis, leaving apparently no space for the common cœnosarc. The structure of the polypary may, however, have been similar to what will be presently described as existing in Hall's genus *Climacograptus*.

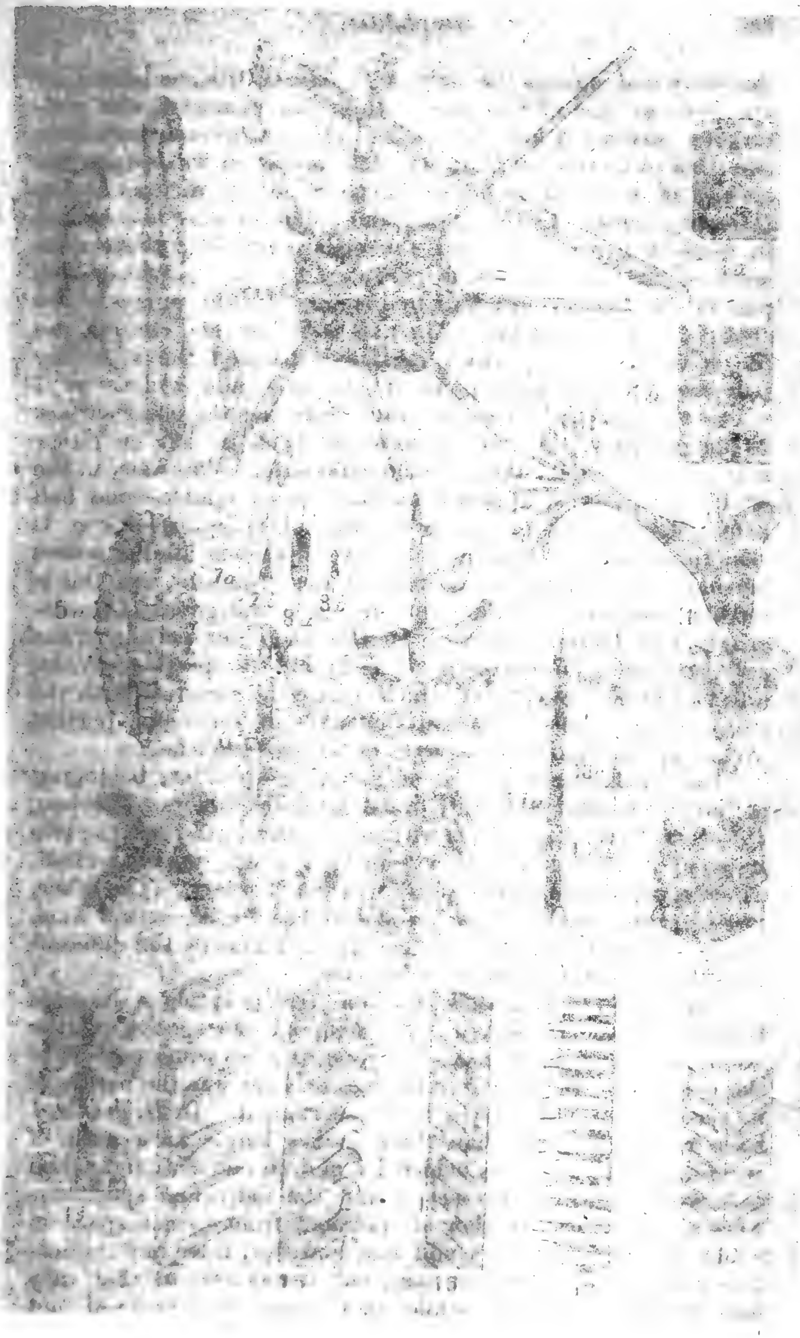
The double graptolite, for which M'Coy proposed the name *Diplograpsus*, appears to differ little, if at all, from the structure of the single forms. We shall have a correct impression of *D. pristis*, His. (Fig. 18), if we consider it as composed of two specimens of *G. Roemeri*, united back to back, having similar hydrothecæ, but with the posterior portions of the single polyparies removed, which, if present, would separate the animals of the two series, and the solid axis remaining in the centre of the common fleshy basis of the colony. Richter

describes and figures the axis in *D. folium*, His., as lateral, or attached to one of the sides, while the cœnosarc was continuous between it and the other side. A different structure has been observed by Hall, who has proposed to separate the species of which it is a characteristic into a distinct genus *Climacograptus*. In this group the polypites were not lodged in distinct hydrothecæ, but the cells containing them were enclosed in the continuous chitinous polypary, which was pierced at regular intervals by openings for the egress of the animals (Figs. 4 and 13). The axis is filiform and central, and the triangular plate, which partially separated the adjoining polypites, rises from a point in the axis, and widens as it passes upwards and outwards, until it reaches the outer surface of the polypary. A free space would thus be left on either side of the axis for the common cœnosarc. This axis, in the double graptolites, appears to have been double—one half belonging to each of the two series of polypites—for it is sometimes seen to separate into two divisions after it passes beyond the polypiferous portion of the organism, and this is further confirmed by the structure of a sub-genus (*Dicranograptus*) of *Climacograptus*. In this the older portion of the polypary has a double series of cells, but it speedily divides into two branches, each of which agrees in structure with the genus *Graptolithus*. The internal axis of the older portion breaks up into the external axes of the two branches.

Two remarkable genera of double graptolites, belonging perhaps to a different family, must be noticed here. The one, *Retiolites*, Barr. (Fig. 12), is without a central axis, and the two series of cells rise on either side of a single internal canal, which occupies the central portion of the polypary. The other, *Phyllograptus*, Hall (Figs. 5 *a* and *b*) has a solid central axis, but is destitute of a common canal, the plates of the different cells being continued to the solid axis.

The presence of a solid axis in all true graptolites deserves special notice. In several, if not in all the species of the family, it is continued naked beyond the growing portion of the polypary. How far it extended, or what was the nature of its termination, has not yet been ascertained. In *D. pristis*, I have noticed it more than three inches long. In a mass of specimens of this species, which I found on one slab, the naked axes were beautifully preserved, and the individual specimens were arranged so that they all radiated from a small space in which the axes met. I could not, however, trace any connection between the different axes, but it was evident that they had become entangled while they were yet fresh—if not actually living.

The appearance on this slab did not in the least correspond



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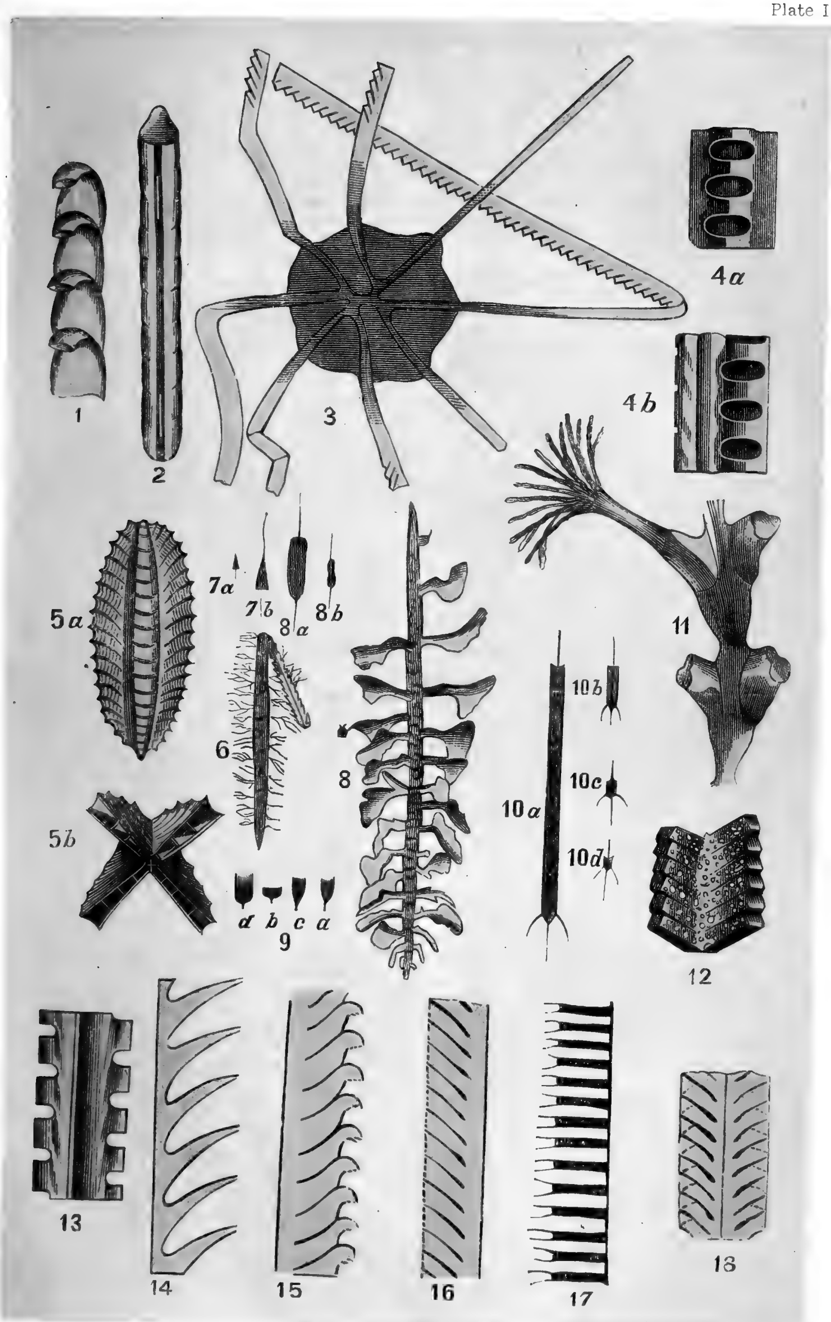


STRUCTURE OF GRAPTOLITES.

to the aspect of Hall's remarkable genus, which he has named *Retiograptus*, in which the connecting axis is prolonged from the older portion of the organism. But the discovery of this form by Hall suggested the possibility of the supposed perfect specimens of *Diplograpsus* being only fragments of more complex forms, and on laying this slab open my first impression was that I had discovered such a perfect polypary. A connection by means of the growing axis would be somewhat anomalous, unless we supposed that the growth of the graptolite was like that of those oceanic hydrozoa whose hydrosoma consists of several polypites connected by a flexible filiform cœnosarc, which grows at its newer portion, or where it is attached to the swimming bell. But that this could not have been the method of growth is shown by the branching and rebranching form to which I gave the generic name of *Cladograpsus*, the ultimate divisions of the polypary of which has the axis produced beyond the growing polypiferous, and necessarily free portion. Neither could there have been any connection in *Diplograpsus* by the axis prolonged from the proximal end of the organism, for innumerable specimens show that it terminated at this end in one, two, or three spines or processes. In *D. scalaris*, His., the termination is simple; in *D. bicornis*, Hall, double; and in *D. tricornis*, Car., triple. The form and size of these processes can be distinctly seen, so that the organism must be considered complete at this the proximal end.

The openings of the hydrothecæ are, in some species, furnished with one or more processes (Fig. 17), in some short and firm, in others long and slender.

Form. The general form of the graptolite was, first, that of a slender, linear, indefinitely-produced polypary with a single series of cells, either simple (*Graptolithus*, L.), twice branched (*Didymograpsus*, M'Coy), symmetrically branched on either side of a primary point (*Tetragrapsus*, Salter, etc.), or repeatedly and irregularly branched (*Cladograpsus*, Car. not Gein.); or, second, a shorter and broader polypary with two series of cells (*Diplograpsus*, M'Coy), etc.

A more complex form has been found in America, which is considered by Hall as exhibiting the perfect polypary of the genus *Graptolithus*. The organism (Fig. 3) orignates in a short, barren process called the "radicle," which divides into two branches, which again divide more or less frequently, the portion of the polypary being without polypites until beyond the place of the final branching. The barren bases of the branches are united by a central disc composed of the same substance as the graptolite, and consisting of two layers, which, at least in the centre, are not united. Whether or not all the

American species of *Graptolithus* are fragments of this more complex form, I cannot say; but it is certain that few, if any, of our European species could belong to it. In many species, the termination of both extremities of the polypary is known, and that end by which they should be united to the compound group is certainly free. Salter was right in considering this compound form as the type of a different genus, to which he gave the name *Dichograpsus*.

There is no indication in any of the forms of a hydrorhiza, or of any means by which the polypary could have been attached to a foreign body. In the branching forms a slender initial process can generally be detected, to which Hall has given the name "radicle," but he does not consider this to have been a means of attachment, and it is not possible that it could have been so. We must consider that the graptolites possessed free polyparies.

Development. In 1858, I drew attention to young specimens of *D. tricornis*, and published a drawing of one; and in the following year Hall figured the young of apparently the same species. At the earliest stage these show all the characters of the adult. There is the solid axis continued above the polypary, and the three spines at the proximal end. Whether the "radical" in branching forms be the initial point in the development, it is evident, that the axis exists in the earliest state of *Diplograpsus*. At first a thin membrane is spread out between the spines and the slender axis at the distal end (Fig. 10 *d*). Next, there appear distinct indications of the hydrothecæ (Fig. 10 *b* and *c*); and these increase in number until the organism attains considerable size (Fig. 10 *a*). I have traced the history of *D. pristis* from a very young form like what has been by Mr. Nicholson, in the current volume of the *Geological Magazine*. At first they appear as triangular bodies, with the axis developed at both extremities (Fig. 7 *a* and *b*). The apex is the proximal end, and at the base the cells are developed (Fig. 8 *a* and *b*). In *Didymograpsus* I have observed specimens in which Hall's "radicle," with a single cell on either side has formed the whole polypary.

The origin of these minute forms has not been clearly traced. Hall figures a species of *Diplograpsus*, bearing what he believes to be reproductive sacs. This figure is reproduced on our plate (Fig. 8). Nothing like this has yet been found in Europe, but I have found several specimens of *D. pristis*, showing a series of interlacing fibres rising from the hydrothecæ (Fig. 6), similar to what Hall figures as the marginal fibre by which the reproductive sacs were attached to the axis of the graptolite, but from which the sacs themselves had been removed by maceration. He figures in connection with these

sacs a young specimen just beyond the margin and barely separated from the fibres of the sac (Fig. 8), and another below the sac. It has been recently supposed that numerous pedicellate bodies (Fig. 9) found in the graptolitic shales of Dumfriesshire are ovigerous vesicles, but as yet no case has been observed in which a relationship could be certainly traced between the fossil and the graptolites, and consequently the true nature of these bodies is very doubtful.

The first developed hydrothecæ are generally smaller than those formed later, making the outline of the polypary taper towards the older portion. In the genus *Graptolithus,* the earlier cells are sometimes more slender, and more separate from each other than they are afterwards. When the perfect size and form is attained, the additional hydrothecæ are exact repetitions of each other, and the polypary is parallel sided. In a few cases the newer as well as the older cells are small, as in *Phyllograptus* (Fig. 5 *a*) and in *D. folium,* His., in which the depth of the cells is increased by layers added to the mouth.

EXPLANATION OF PLATE.

Fig. 1. *Graptolithus priodon.* View showing the mouths of the hydrothecæ.

Fig. 2. Back view of ditto, showing the slender, solid axis.

Fig. 3. The disc and portion of the branches of *Dichograpsus.*

Fig. 4. *Climacograptus scalaris.* *a,* showing the cell openings in front; *b,* showing a portion of the second series of openings.

Fig. 13. Showing both series, preserved at right angles to that shown at Fig. 4.

Fig. 5. *Phyllograptus ilicifolius.* *b,* ideal section, showing the four series of cells. From Hall.

Fig. 6. *Diplograpsus pristis.* Specimen from which the reproductive sacs are supposed to have been removed (by maceration), leaving the marginal fibres by which they were attached.

Fig. 7. Young state of the same species.

Fig. 8. *Diplograpsus,* figured by Hall.

Fig. 9. Pedicellate bodies referred to in text.

Fig. 10. *Diplograpsus tricornis,* showing different stages in its growth between its adult condition, 10 *a,* and its youngest state, 10 *d.*

Fig. 11. Four cells and a polypite of the recent Sertularian, *Dynamena pumila.*

Fig. 12. *Retiolites Geinitzianus.* A fragment magnified.

Fig. 14. *Graptolithus convolutus.* ditto.

Fig. 15. *Graptolithus priodon.* Section magnified.
Fig. 16. *Graptolithus Roemeri.* ditto.
Fig. 17. *Rastrites*, sp. Fragment magnified.
Fig. 18. *Diplograpsus pristis.* Section magnified.

(*To be concluded in an early number.*)

A WHITE CLOUD ILLUMINATION FOR LOW POWERS.

BY HENRY J. SLACK, F.S.A., HON. SEC. R.M.S.

Microscopists have long adopted various modes of obtaining what is technically known as a "white cloud illumination," or illumination resembling that of solar light reflected from a white cloud. Some years ago a favourite plan was the employment of a disc of plaster of Paris in the place of the flat mirror; but such discs soon get dirty, and are therefore inconvenient. The white porcelain glass shades of lamps, like Mr. Pillischer's, enable an effect of this kind to be obtained, by so arranging a bull's-eye condenser, or stage mirror, that no direct light from the lamp-flame reaches the object, but only such rays as have previously suffered reflection from the porcelanous surface.

Another method employed with advantage, and recommended many years ago by the writer, was to take a disc of white foreign post paper, place it on a stouter paper, cover it with a few little bits of spermaceti and hold it over a lamp till the thin paper was thoroughly saturated with the molten matter. Such a piece of paper can be inserted in the frame carrying a bull's-eye, next its flat surface, or may be placed in the diaphragm hole under the stage. A still better plan for all but very low powers is to cut a small square or disk of the thin paper about seven-eighths of an inch in diameter, place it on an ordinary slide, in the middle, saturate it with spermaceti, and while the latter is hot place over it a thin covering glass, of a trifle larger size. This keeps the spermaceti always clean. The way to use it is to place the spermaceti slide on the stage, and the slide, carrying the object to be viewed, upon it. This gives a very pleasing illumination, and answers for all powers sufficiently high not to focus through the object-slide and show the surface of the spermaceti paper below it.

When using a binocular instrument, with powers of $1\frac{1}{2}$ to 3 inches, ordinary methods fail to produce the soft, luminous, and opaque-looking background which is best fitted for large

transparent objects, and which ought to be as uniform as possible in brilliance throughout its whole extent. A single piece of ground glass gave upon trial an imperfect result, and the writer then went to Mr. Browning's factory, and selected a double concave lens, such as is used in telescope manufacture, about $1\frac{1}{2}$ inches in diameter. On one side this lens was ground with emery, and the other polished as usual. A flat disc of plate glass of the same size was also ground on one surface, and placed upon the lens so that the two ground surfaces were in contact. Mr. Browning then, by the writer's direction, cemented the two glasses by their edges, and mounted them in a brass cell fitting the substage apparatus of the microscope.

Nothing could be better than the effect thus obtained. Objects, such as insects mounted whole, the head and antennæ of the plumed gnat, delicate, transparent, anatomical preparations, came out beautifully with the binocular and powers of $1\frac{1}{2}$ to 3 inches. The extreme softness of the light was commended by several experienced observers, and persons with sensitive eyes declared that they could view the objects steadily without fatigue.

It was obvious that by grinding one surface of the lens, its action as a lens must be greatly interfered with, but the experiment was made in the belief that it would still exert a more dispersive action than a flat piece of glass. To test this, Mr. Browning was asked to grind two flat discs of plate glass on one side only, and they were found to perform so nearly as well as the combination of flat disc and lens, that the writer is disposed to recommend them instead, as they are cheaper. Comparative experiments seemed to show a slight superiority in the lens combination, which is certainly less pervious to light. When one disc of ground glass only was tried, the effect was far less satisfactory than with the two.

These discs should be cemented together while their ground surfaces are fresh. All dust is thus excluded, and the permanent whiteness of the field ensured. Different kinds of glass grind with different degrees of whiteness, and that which gives the most snowy-looking surface should be selected.

Almost every microscopist has doubtless used ground glass for this purpose; but those who try two ground surfaces instead of one, and adopt the method here pointed out for keeping them clean, cannot fail to be pleased with the result.

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

BY G. M. WHIPPLE.

1867.	Reduced to mean of day.					Temperature of Air.			At 9·30 A.M., 2·30 P.M., and 5 P.M., respectively.		
			Calculated.								
Day of Month.	Barometer, corrected to Temp. 32°.*	Temperature of Air.	Dew Point.	Relative Humidity.	Tension of Vapour.	Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9·30 A.M.	Daily Range.	Proportion of Sky clouded.	Direction of Wind.	Rain—read at 10 A.M.
	inches.	°	°		inch.	°	°	°	0—10		inches.
Jan. 1	29·369	28·3	24·2	·86	·174	31·6	24·3	7·3	2, 2, 2	NNW, N, W by N.	0·000
„ 2	29·177	26·4	...	...	·163	28·7	19·9	8·8	10, 7, 5	NNE, N, N by W.	1·167†
„ 3	29·788	24·2	...	...	·150	28·6	5·7	22·9	10, 10, 10	SW, N by E, NW.	—
„ 4	29·981	10·7	...	...	·092	21·6	5·0	16·6	10, 5, 10	SW, —, NW by N.	—
„ 5	29·965	26·5	...	...	·164	30·8	1·0	29·8	10, 10, 10	E, E, ESE.	—
„ 6	...	...	...	...	...	48·7	21·1	27·6	...	... ...	—
„ 7	29·138	50·5	48·2	·92	·380	54·7	32·3	22·4	10, 9, 8	S, SW, SSW.	·750‡
„ 8	28·936	46·2	40·8	·83	·328	52·6	48·3	4·3	10, 8, 2	SW by W, WSW, SW by W.	·220
„ 9	28·923	44·3	40·2	·87	·307	47·8	39·7	8·1	10, 10, 10	S by W, SW, SSW.	·000
„ 10	29·266	39·0	32·3	·79	·255	41·2	39·6	1·6	4, 9, 10	NNW, NW, NW.	·270
„ 11	29·672	32·4	26·5	·81	·202	36·3	31·2	5·1	4, 3, 0	NNE, NNW, NNW.	·000
„ 12	29·591	29·6	26·4	·89	·183	32·3	22·4	9·9	7, 10, —	SSW, W, WNW.	·000
„ 13	...	...	...	...	...	29·2	17·5	11·7	...	... ...	·080†
„ 14	29·875	22·0	...	...	·139	29·8	10·5	19·3	0, 0, 0	SW, NW by W, —.	·000
„ 15	29·913	27·0	...	...	·167	31·3	14·3	17·0	0, 1, 5	N, N, NW by N.	·000
„ 16	29·759	30·9	25·5	·83	·191	34·7	24·1	10·6	5, 10, 10	N, NNE, N.	·000
„ 17	29·509	26·8	...	...	·165	29·8	27·9	1·9	7, 7, 2	NW by N, N, NW.	·000
„ 18	29·545	28·0	...	...	·173	31·1	23·3	7·8	10, 7, 10	W by N, NW, N by E.	·000
„ 19	29·863	26·0	...	...	·160	32·0	21·2	10·8	5, —, —	SW, —, —.	·017†
„ 20	...	...	...	...	...	31·1	21·8	9·3	...	... ...	·000
„ 21	29·858	27·7	20·4	·77	·171	29·3	28·0	1·3	10, 9, 10	E by N, E by N, E by N.	·000
„ 22	30·014	25·0	22·7	·92	·155	26·6	23·0	3·6	10, 10, 10	SE, ESE, E by S.	·000
„ 23	29·692	46·4	46·2	·99	·330	49·9	21·0	28·9	10, 10, 10	S by W, SW by S, S by W.	·090
„ 24	29·471	50·6	48·2	·92	·381	54·8	45·5	9·3	10, 9, 8	SW, SW by W, SW.	·009
„ 25	29·602	44·5	38·1	·80	·309	49·8	38·1	11·7	10, 8, 3	W by S, W by N, W by N.	·020
„ 26	29·984	41·0	37·8	·89	·273	54·2	39·0	15·2	10, 10, 10	WSW, S by E, S by E.	·000
„ 27	...	...	...	...	...	56·4	40·7	15·7	...	... ...	·260
„ 28	29·848	50·0	46·0	·87	·373	52·8	49·3	3·5	10, 10, 3	SW, SW, W by S.	·006
„ 29	29·939	46·6	43·3	·89	·332	52·2	39·4	12·8	3, 10, 10	S by W, SW, SW.	·000
„ 30	29·686	48·1	45·4	·91	·350	51·8	44·5	7·3	7, 10, 10	SW by W, SW, SW by S.	·080
„ 31	30·173	42·2	33·1	·73	·285	46·9	37·8	9·1	1, 5, 10	W by N, W by N, SSW.	·404
„											
Daily Means.	29·649	34·8	(35·8)	(·86)	·235	...	...	12·0	...	... ...	3·373

* To obtain the Barometric pressure at the sea-level these numbers must be increased by ·037 inch.

† Equivalent of snow in rain. ‡ Melted snow and rain.

HOURLY MOVEMENT OF THE WIND (IN MILES), AS RECORDED BY ROBINSON'S ANEMOMETER.—JANUARY, 1867.

Day. / Hour.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Hourly Means.
A.M. 12–1	5	5	1	1	0	30	16	40	13	23	7	8	10	3	7	15	19	5	4	17	29	18	10	18	2	19	19	17	7	22	14	13·0
1–2	10	6	1	2	1	32	17	38	15	25	9	8	10	1	3	15	20	4	3	23	24	14	9	19	4	15	18	14	8	22	18	13·2
2–3	13	12	1	3	0	35	18	39	17	20	7	7	10	2	3	17	21	6	4	23	24	10	10	19	3	10	18	15	7	24	11	13·2
3–4	11	16	1	2	1	20	18	43	15	19	8	7	8	2	9	17	19	5	5	29	28	13	6	20	3	10	19	15	13	24	15	13·6
4–5	17	16	2	1	1	17	20	53	17	23	8	6	6	1	13	16	19	6	3	25	30	14	4	30	3	6	15	18	12	22	14	14·1
5–6	11	22	0	1	1	18	17	33	19	19	8	3	9	1	10	19	18	5	4	26	29	10	12	26	1	8	15	19	14	15	15	13·2
6–7	13	35	3	1	1	16	18	40	17	17	10	5	10	1	8	21	17	4	1	31	31	11	9	19	2	5	15	18	12	16	12	13·5
7–8	15	24	2	3	3	19	19	35	20	17	13	8	6	0	9	21	16	5	1	32	35	10	7	16	4	4	22	19	15	18	10	13·8
8–9	13	33	3	1	7	13	21	31	23	17	12	7	9	0	7	22	14	5	2	30	37	10	10	18	4	5	16	19	19	11	8	13·8
9–10	12	29	3	1	8	12	22	38	20	18	12	9	7	1	7	17	13	5	1	29	36	10	9	19	8	5	17	21	20	14	11	14·0
10–11	14	30	3	2	9	8	22	23	22	16	17	13	10	3	6	23	15	6	5	30	32	8	13	18	7	4	17	21	18	18	15	14·5
11–12	13	27	2	1	8	7	28	30	20	17	16	17	11	4	7	23	17	6	2	37	31	13	14	20	13	4	17	21	21	18	25	15·8
P.M. 12–1	11	26	2	2	6	6	25	26	23	19	15	13	10	3	11	27	19	4	8	34	32	12	15	23	13	7	19	22	23	16	22	15·9
1–2	10	24	2	2	13	5	23	21	28	16	15	13	11	3	11	25	17	5	4	35	30	10	11	17	17	6	15	21	24	16	19	15·1
2–3	7	23	3	0	17	5	19	24	32	16	11	11	10	8	10	25	14	5	10	31	28	10	9	19	14	6	13	18	21	8	16	14·0
3–4	6	16	3	0	19	2	21	19	32	14	14	16	5	4	8	21	13	6	10	30	24	11	11	16	18	7	10	19	19	13	13	13·5
4–5	4	15	3	2	22	4	20	16	28	15	9	14	4	5	10	19	12	5	9	36	30	10	11	12	16	10	11	16	21	19	6	13·3
5–6	6	7	3	1	23	1	24	14	22	13	10	13	3	2	11	18	14	6	7	34	24	12	13	10	9	13	11	23	23	29	6	13·1
6–7	4	9	5	0	26	2	27	18	26	10	9	12	2	3	15	18	10	7	12	37	26	11	19	12	15	17	13	17	23	31	4	14·2
7–8	2	6	4	0	28	2	25	14	20	8	9	16	5	4	13	16	8	7	18	38	25	16	17	4	14	17	11	18	23	29	7	13·7
8–9	4	5	3	1	26	10	27	14	22	10	10	7	2	3	14	16	8	5	13	40	19	17	20	6	16	19	13	16	22	23	9	13·5
9–10	3	3	4	0	25	10	27	13	23	9	10	7	5	5	16	18	5	5	14	33	17	13	15	5	16	25	11	11	24	18	6	12·8
10–11	3	3	2	1	29	13	34	14	25	10	9	10	5	5	16	19	9	6	10	38	20	13	21	5	18	20	15	9	25	15	11	14·0
11–12	5	2	3	0	25	14	38	17	21	8	11	10	3	2	13	17	6	7	14	35	24	11	17	4	17	18	16	12	21	12	9	13·3
Total Daily Movement.	212	394	59	28	299	301	546	653	520	379	259	240	171	66	237	465	343	130	164	753	665	287	292	375	237	260	366	419	435	453	296	13·8

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

1867. Day of Month.	Reduced to mean of day. Barometer corrected to Temp. 32°.*	Temperature of Air.	Calculated. Dew Point.	Relative Humidity.	Tension of Vapour.	Temperature of Air. Maximum, read at 9.30 A.M. on the following day.	Minimum, read at 9.30 A.M.	Daily Range.	At 9.30 A.M., 2.30 P.M., and 5 P.M. respectively. Proportion of Sky clouded.	Direction of Wind.	Rain—read at 10 A.M.
	inches.	°	°		inch.	°	°	°	0—10		inches.
Feb. 1	30·099	46·6	46·0	·98	·332	50·0	...	...	10, 10, 10	SW, SW, SW by S.	0·000
„ 2	30·054	45·1	33·7	·67	·315	49·2	43·9	5·3	0, 5, 4	WSW, W, W by N.	·000
„ 3	...	...	...	...	...	46·4	32·0	14·4	...	... ...	·000
„ 4	29·538	43·5	41·9	·94	·298	49·4	36·2	13·2	10, 10, 6	SSW, SW, W by S.	·010
„ 5	29·280	42·9	41·2	·94	·292	54·1	35·2	18·9	9, 10, 10	SSW, S by W, SW.	·101
„ 6	28·911	43·2	37·6	·83	·295	49·8	41·1	8·7	8, 5, 3	W, W, W by S.	·174
„ 7	29·664	40·5	27·3	·63	·269	52·6	36·0	16·6	0, 5, 10	W by N, W, SW by W.	·005
„ 8	29·387	49·8	45·1	·85	·371	54·7	39·6	15·1	10, 10, 8	W, SW by W, WSW.	·190
„ 9	29·948	47·2	39·1	·76	·339	52·6	43·5	9·1	0, 6, 10	W, WSW, SW.	·025
„ 10	...	...	...	...	...	51·8	45·0	6·8	...	... ...	·055
„ 11	30·124	42·1	32·2	·71	·284	46·5	40·1	6·4	0, 9, 8	WNW, W, WSW.	·234
„ 12	30·245	48·2	45·0	·89	·351	50·9	40·6	10·3	10, 10, 10	W by S, WNW, W by N.	·000
„ 13	30·357	46·1	43·7	·92	·326	49·5	44·6	4·9	10, 10, 10	WSW, W by S, SW by W.	·004
„ 14	30·291	46·7	41·1	·82	·333	50·4	45·1	5·3	10, 7, 0	E, E by N, ENE.	·000
„ 15	29·890	48·8	39·9	·73	·358	54·8	41·2	13·6	2, 8, 10	E by N, SSE, S by W.	·000
„ 16	29·790	49·8	46·4	·89	·371	55·8	44·4	11·4	9, 5, 7	S by E, SSW, S.	·090
„ 17	...	...	...	...	...	55·8	44·1	11·7	...	... ...	·331
„ 18	30·433	41·9	42·3	1·00	·282	46·2	41·1	5·1	10, 10, 10	E by S, E by S, SE by E.	·000
„ 19	30·342	46·2	43·9	·92	·328	51·1	40·1	11·0	10, 10, 10	SE by E, SE by S, SSE.	·000
„ 20	30·476	49·7	43·6	·81	·369	54·8	44·3	10·5	10, 2, 2	SSW, W, SW by W.	·000
„ 21	30·515	47·6	43·9	·88	·344	51·6	41·0	10·6	10, 10, 10	SW, WSW, SW by S.	·000
„ 22	30·427	46·8	43·6	·90	·334	50·8	46·0	4·8	10, 10, 10	SSW, WSW, WSW.	·000
„ 23	30·481	47·4	37·3	·70	·341	52·4	41·9	10·5	7, 2, 6	NW by N, NW by N, W by N.	·000
„ 24	...	...	...	...	...	52·7	37·1	15·6	...	... ...	·001
„ 25	30·160	44·5	35·1	·72	·309	49·8	37·1	12·7	7, 9, 3	W, W, W by S.	·000
„ 26	30·010	39·0	36·0	·90	·255	41·5	40·5	1·0	10, 10, 10	N, WNW, W.	·013
„ 27	30·067	37·1	26·0	·67	·239	40.7	36·8	3·9	10, 10, 10	E, E by N, E by S.	·020
„ 28	30·236	38·0	28·0	·70	·246	42·9	34·1	8·8	9, 6, 7	E, NE, NE.	·000
Daily Means.	30·030	44·9	39·2	·82	·316	...	...	9·9	...	... ...	1·253

* To obtain the Barometric pressure at the sea-level these numbers must be increased by ·037 inch.

HOURLY MOVEMENT OF THE WIND (IN MILES), AS RECORDED BY ROBINSON'S ANEMOMETER.—FEB., 1867.

Day.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	Hourly Means.
Hour. 12																													
A.M. 1	10	15	8	16	13	24	16	28	27	12	27	16	7	6	11	17	1	2	5	3		10	14	7	11	25	2	6	12·5
2	13	17	5	13	14	23	17	18	26	14	19	16	4	7	14	14	2	2	5	3		11	13	7	9	25	2	8	11·9
3	15	15	9	16	12	30	13	18	24	16	8	14	4	10	18	16	1	4	8	4	150	6	9	8	6	20	0	9	11·6
4	15	15	6	18	11	42	14	17	19	16	9	15	5	7	19	18	1	4	5	5		5	7	7	9	20	2	7	11·8
5	16	16	9	19	11	33	10	18	21	18	5	15	7	9	14	14	1	4	3	5		5	5	8	10	19	4	9	11·4
6	15	13	5	17	13	24	10	25	20	20	9	11	5	7	13	13	1	6	5	3		5	7	11	7	16	9	10	11·1
7	15	13	5	18	15	23	11	24	21	22	14	11	6	8	18	15	3	4	7	4		10	6	15	11	15	6	13	12·3
8	15	10	9	19	14	27	14	26	14	18	16	12	5	9	18	15	2	4	5	7		13	9	12	9	9	13	10	12·4
9	12	8	5	21	16	22	20	27	10	17	20	11	5	11	15	14	2	8	5	5		12	8	18	9	7	11	12	12·3
10	9	12	7	22	18	32	22	22	11	15	18	13	4	15	20	13	3	5	4	3		12	8	12	14	10	15	11	13·0
11	11	18	8	27	18	33	23	27	13	20	22	9	4	15	13	15	2	5	8	4	12	14	15	21	16	8	14	13	14·6
12	11	19	10	27	20	34	27	26	16	21	25	14	3	15	13	15	3	10	9	6	12	14	16	21	17	9	15	14	15·8
P.M. 1	11	21	10	26	20	31	31	31	14	21	24	15	3	12	14	15	2	10	9	10	13	15	16	20	14	8	13	15	15·8
2	13	21	13	25	24	34	29	28	11	20	22	13	2	17	15	15	3	10	8	11	10	16	13	24	13	6	15	11	15·8
3	14	18	10	23	21	27	29	26	9	20	23	11	4	16	17	10	4	8	9	11	15	16	12	19	12	2	12	19	14·9
4	14	16	7	21	15	33	20	24	7	25	26	11	1	17	15	9	1	7	9		13	17	8	23	12	9	17	16	14·5
5	17	10	9	16	12	32	14	21	9	26	15	11	3	15	21	10	1	9	7		13	14	6	18	12	5	11	13	13·0
6	15	9	9	12	13	24	11	21	7	22	10	14	2	11	14	8	3	6	6		7	13	5	18	12	5	9	11	11·0
7	17	8	10	17	16	24	12	21	5	20	23	5	2	10	17	6	1	6	3		9	14	2	18	13	3	7	7	11·0
8	18	9	9	17	14	25	14	22	8	25	12	5	3	10	21	1	1	9	5		9	14	3	18	17	3	7	8	11·4
9	17	8	8	12	13	24	13	20	5	24	12	6	3	5	18	6	1	10	8		15	14	4	16	16	4	5	10	11·0
10	17	7	11	10	25	24	17	18	7	30	13	7	3	7	17	3	1	10	5		12	13	4	13	21	3	5	7	11·5
11	17	7	14	14	25	22	21	22	9	30	15	7	5	11	23	1	2	9	3		8	12	5	8	21	5	10	8	12·4
12	18	7	18	11	24	20	24	23	10	26	14	6	6	7	19	1	2	3	2		8	11	5	10	22	3	7	9	11·7
Total Daily Movement.	345	312	214	437	397	667	432	553	323	498	401	268	96	257	397	264	44	155	143	390		286	200	352	313	239	211	256	12·5

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

1867. Day of Month.	Reduced to mean of day. Barometer, corrected to Temp. 32°.*	Temperature of Air.	Calculated. Dew Point.	Relative Humidity.	Tension of Vapour.	Temperature of Air. Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9·30 A.M.	Daily Range.	At 9·30 A.M., 2.30 P.M., and 5 P.M., respectively. Proportion of Sky clouded.	Direction of Wind.	Rain—read at 10 A.M.
	inches.	°	°		inch.	°	°	°	0—10		inches
Mar. 1	30·558	35·3	27·4	·75	·224	40·6	28·5	12·1	7, 10, 8	N, NE, N.	0·000
„ 2	30·727	32·4	22·8	·71	·202	37·8	31·4	6·4	10, 4, 9	NE, NE, E by N.	·000
„ 3	...	...	...	...	...	41·7	29·1	12·6	9, 0,	... ...	·000
„ 4	30·403	39·0	31·1	·76	·255	45·1	34·5	10·6	9, 1, 3	NE, NE by E, NE.	·033
„ 5	30·077	40·4	33·6	·79	·268	46·9	34·6	12·3	10, 3, 5	NNE, NE by E, NNE.	·004
„ 6	29·749	33·8	29·5	·86	·212	39·6	33·3	6·3	10, 10, 8	N by E, E by S, E.	·000
„ 7	29·621	31·8	29·3	·91	·198	36·7	30·5	6·2	10, 5, 8	E by N, NE, NE.	·040
„ 8	29·525	32·8	27·3	·82	·205	38·1	30·6	7·5	10, 9, 7	NE, ENE, ENE.	·027
„ 9	29·465	34·1	29·8	·86	·215	40·2	30·5	9·7	10, 10, 10	NE, E by N, —.	·000
„ 10	...	...	...	...	...	43·8	34·1	9·7	...	... ...	·429
„ 11	29·663	34·8	31·4	·88	·220	38·8	35·0	3·8	10, 10, 10	NE by N, NE, E by N.	·024
„ 12	29·778	32·1	28·5	·88	·200	37·7	31·5	6·2	10, 10, 10	NE, by E, E, E by N.	·144†
„ 13	29·839	28·5	24·9	·88	·176	33·8	4·0	29·8	10, 10, 10	ENE, E, E.	·004
„ 14	29·540	30·7	31·2	1·00	·190	35·2	28·7	6·5	10, 10, 10	NE by E, NNE, NE by W.	·430†
„ 15	29·753	33·5	27·7	·81	·210	38·7	30·6	8·1	10, 8, 7	NE by N, NNE, N by E.	·096†
„ 16	29·941	33·4	23·7	·71	·209	40·5	25·0	15·5	5, 5, 2	NW by N, NE, NE by N.	·000
„ 17	...	...	...	...	...	36·9	27·3	9·6	...	... ...	·000
„ 18	29·494	28·9	...	...	·178	32·7	11·5	21·2	10, 10, 10	E, E, E by S.	·000
„ 19	29·313	32·1	32·4	1·00	·200	36·0	30·3	5·7	10, 10, 10	E by N, ENE, NE.	·050†
„ 20	29·539	33·7	29·3	·86	·212	38·7	33·0	5·7	10, 10, 9	NNE, N by E, N.	·164†
„ 21	29·845	33·9	26·3	·76	·213	39·7	29·5	10·2	4, 10, 10	NE by E, ESE, E.	·000
„ 22	29·680	36·7	36·4	·99	·235	43·3	30·4	12·9	10, 10, 10	E by S, W by S, SW by S.	·270†
„ 23	29·640	47·5	46·1	·95	·343	54·4	34·6	19·8	10, 10, 9	SE, S, SSE.	·000
„ 24	...	...	...	...	...	56·3	45·9	10·4	...	... ...	·062
„ 25	29·625	46·8	45·8	·97	·334	53·1	45·3	7·8	10, 10, 10	SW, SE by S, S by W.	·000
„ 26	29·379	50·0	41·2	·74	·373	55·9	47·3	8·6	5, 4, 4	SW by S, NW, NW.	·100
„ 27	29·312	47·3	41·7	·82	·340	54·3	42·4	11·9	10, 10, 7	SW, SSW, SW.	·000
„ 28	29·412	44·9	32·8	·66	·313	51·8	34·3	17·5	3, 6, 2	W by N, SW, WNW.	·023
„ 29	29·623	44·7	32·4	·65	·311	50·3	34·8	15·5	5, 8, 10	W by N, WNW, W by N.	·000
„ 30	29·729	44·7	36·9	·76	·311	52·5	35·8	16·7	4, 7, 9	W, W by S, WSW.	·000
„ 31	...	...	...	...	...	47·9	36·2	11·7	...	... ...	·080
Daily Means.	29·740	37·0	32·0	·83	·244	...	...	11·2	...	... ...	1·980

* To obtain the Barometric pressure at the sea-level these numbers must be increased by ·037 inch.
† Melted snow and rain.

HOURLY MOVEMENT OF THE WIND (IN MILES), AS RECORDED BY ROBINSON'S ANEMOMETER.—MARCH, 1867.

Day.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Hourly Means.
Hour. 12	9	9	16	19	14	9	15	7	10	30	8	10	34	30	7	3	8	35	10	11	9	20	4	12	17	17	15	6	7	6	23	13·2
A. M. 1	7	10	15	17	11	6	14	10	8	31	8	11	29	29	4	2	10	37	11	12	8	22	3	9	17	19	13	7	9	7	25	13·7
2	4	11	15	16	19	7	16	10	6	33	5	13	29	22	6	3	10	36	16	12	10	22	5	6	15	25	11	6	6	8	24	13·8
3	5	11	15	13	16	8	16	7	7	33	4	12	31	23	7	3	8	32	14	10	7	23	5	8	15	29	9	6	8	10	20	13·4
4	5	9	20	10	18	4	14	8	7	32	6	16	32	19	8	3	11	35	10	10	9	20	6	9	16	26	9	6	7	10	18	13·0
5	5	6	17	11	21	2	15	10	7	24	6	16	30	18	12	2	10	34	15	10	9	19	8	6	11	25	11	5	8	7	15	12·7
6	4	9	18	21	21	10	11	9	6	19	6	17	29	21	9	2	10	34	14	10	7	17	6	4	14	30	12	6	7	10	17	13·2
7	1	8	21	22	19	11	10	9	5	16	9	19	34	19	9	4	9	35	16	10	7	16	13	4	12	32	15	7	5	7	21	13·7
8	6	12	22	24	16	16	10	11	9	14	10	16	33	21	8	7	11	31	19	13	9	14	10	8	17	35	18	8	9	14	20	15·2
9	10	13	22	18	20	17	12	8	8	14	9	14	33	21	10	10	16	28	22	13	13	15	10	12	17	31	18	10	11	19	19	15·9
10	15	22	23	27	21	20	13	14	11	13	12	18	34	21	14	12	23	27	21	12	16	10	12	13	19	32	17	11	14	17	21	17·9
11	15	23	29	25	21	22	19	16	16	14	11	24	35	20	18	13	24	33	20	17	17	6	20	15	17	31	16	14	13	16	19	19·3
12	13	24	29	21	11	23	16	11	16	13	10	28	34	17	15	18	25	27	22	14	17	5	24	15	17	31	17	12	13	20	18	18·6
P. M. 1	13	22	26	24	18	21	14	11	20	13	6	27	33	16	16	20	25	20	14	16	18	3	26	12	17	32	13	11	12	24	15	18·0
2	10	24	27	24	17	25	15	13	22	15	8	36	31	15	13	14	26	19	18	16	19	9	21	17	21	31	9	15	15	25	15	18·9
3	9	21	22	21	19	16	16	15	25	15	9	36	31	14	15	22	29	17	15	16	20	5	20	19	22	33	14	16	13	26	13	18·8
4	8	20	20	21	17	15	18	17	27	16	7	44	34	16	12	20	28	14	14	15	24	2	20	21	23	28	15	13	15	20	11	18·5
5	7	16	16	20	12	12	13	14	29	17	8	35	28	15	12	18	27	11	13	13	18	2	27	15	14	25	12	10	12	18	11	16·1
6	11	15	19	17	11	18	10	11	29	12	10	38	26	16	7	17	27	12	13	13	19	4	26	15	25	22	8	14	10	16	8	16·1
7	10	11	22	18	12	18	10	11	30	10	12	32	26	18	5	14	28	11	13	11	15	4	24	14	17	18	6	11	11	15	5	14·9
8	11	12	17	10	15	15	7	10	33	9	13	28	26	15	3	10	32	10	12	11	16	3	22	15	19	15	4	10	11	15	5	14·0
9	12	16	17	12	11	16	6	10	33	10	15	33	29	10	7	8	32	10	13	9	18	4	19	22	16	12	5	6	9	11	1	14·0
10	10	15	20	14	7	17	9	10	32	11	11	39	30	10	8	7	37	9	13	9	17	3	17	24	20	14	5	7	12	19	4	14·8
11	8	14	19	14	5	13	10	9	30	9	10	30	30	9	4	9	35	6	11	9	16	3	10	20	18	15	6	6	7	18	3	13·1
12																																
Total Daily Movement.	208	353	487	439	372	341	309	261	426	426	213	592	741	435	229	241	501	563	359	292	338	251	358	315	416	608	278	223	246	358	351	15·4

BIOGRAPHY OF SWEDENBORG.*

A NEW life of Swedenborg, with an account of his writings, in two bulky volumes, might seem a somewhat perilous experiment upon the taste of the public, and still more so when, as is the case with Mr. White's labours, they can scarcely expect to be accepted as representing the views of the small though energetic sect of which the celebrated Swede is the apostle and prophet. As is the case with nearly all the biographical works that are produced in these days, the present one has the faults of diffusiveness and prolixity. It is written from a point of view remote from that of philosophical criticism, and, in many passages, almost equally so from that of faith in the pretensions of its subject. Mr. White may, perhaps, object to the latter part of this remark, and it is only fair to cite his concluding words, in which he exclaims, "time only adds to the power and clear shining of my author's fame," and affirms that although his claim is "an awful one," "yet the more I study his writings, and learn to disregard their extraneous encumbrances, the more credible does the claim become."

The popular idea of Swedenborg is simply that of a clever man suffering from cerebral derangement, and taking the visions of a disordered imagination for a positive insight into the mysteries of the spirit-world. A little investigation into the personal character and proceedings of the mystic philosopher, as he is displayed in Mr. White's pages, will somewhat modify this idea. Those who accept Swedenborg's claims as prophet and seer, will, of course, deny that he laboured under chronic hallucination, or that cerebral derangement tinctured and characterized all his speculations. On the other hand, those who can see no reason for supposing the illustrious Swede to have been supernaturally endowed, or enlightened, will regard his case as worthy of careful study, upon psychological and medical grounds, and will be induced to place him amongst a class of persons who, in various ages of the world, have exercised great and often enduring influence over their fellow-men, and in whom the normal action of the intellectual powers was modified, though not entirely dominated, by delusion and disease. In many mystics a much greater excitation of the moral and emotional nature was manifested than Swedenborg displayed. In him, the rationalizing and philosophical element predominated all through, and his visions revealed nothing that was not in accordance with the general tenor of thought, proceeding logically from the facts which he was acquainted

* *Emanuel Swedenborg: his Life and Writings.* By William White. 2 vols. Simpkin, Marshall, and Co.

with, and the premises which he accepted. His method of reasoning was defective, but it was a *method*, and not a hap-hazard performance; and when, what most observers would consider his insanity was at its height, it seems to have left his thinking faculties clear, and to have misled him almost exclusively, by inducing him to mistake internal impressions for external facts.

Some peculiarities of Emanuel Swedenborg were derived from his father, concerning whom Mr. White gives many curious particulars, accompanied by a portrait, in which a strong tinge of insanity is apparent. Jesper Svedberg, the father of Emanuel, rose from humble origin to be bishop of Skura. His father's name was Isaksson, and the appellation Svedberg—which by royal orders became lengthened into Swedenborg, in Emanuel's honour—was derived from a piece of property which the family owned. Jesper Svedberg was a remarkably self-satisfied, self-contained man, with an inflexible obstinacy of purpose, and a determination to get on in the world. He believed that angels spoke with him and assisted his plans. Having attained to a respectable pecuniary position, he married a rich wife, and after spending six months with her, obtained permission to absent himself from his duties as Chaplain to the Life Guards of Charles XI., and employed nearly a year in visiting Germany, France, Holland, and England. On his return to Stockholm, he found his wife had presented him with his first son, and a few years later, on the 29th January, 1688, his second son, the future mystic, Emanuel, was born. Jesper Svedberg was always active, whether as simple clergyman or as bishop, and in the main must have been a useful man, though wanting in consideration for the thoughts and feelings of other folks.

Svedberg lost his first wife in 1696, and in the following year espoused a second. The lady upon whom his choice fell had been twice a widow, and he engaged himself to her without having seen her. He states that he was unexpectedly informed of her goodness, piety, excellent housekeeping, sufficiency of property, and absence of children. "What more could be desired?" the shrewd Jesper exclaims, in his narrative. "In a word, she seemed a woman who would suit me well. I wrote to her, and laid bare my thoughts, and she acceded to my request. Two days before my wedding, I went to Stockholm, whither she also, by agreement, repaired. I was put into a room where she was sitting alone; but I did not know, and never imagined it was she, for no man had told me. . . . At length she said, 'What do you think of our bargain, M. Professor?' I replied, 'What bargain do you refer to?' 'That which you have written about,' she said.

'I do not know what you mean,' I answered. 'Are we not,' she said, 'to be man and wife to-morrow?'" Hereupon Jesper Svedberg jumped up, shook hands, and gave a loving embrace to his wife elect!

Swedenborg's father was thus a strange character; hard-working, vigorous, self-seeking, yet duty-loving; quite sure that angels talked with him, and able, as he states, to exorcise devils, and turn them out of mind or body.

Further curious particulars concerning Jesper Svedberg will be found in Mr. White's book; but enough has been said to indicate some of the peculiarities which he transmitted to his son Emanuel.

In 1709, at the age of twenty-one, Emanuel took his degree as Doctor of Philosophy, at Upsala, and in the following year paid his first visit to London, and spent four years in England, Holland, and France. During this period, physical science and mechanical invention chiefly occupied his thoughts, and he designed a ship to float under water, a mode of lifting weights by means of a syphon, a mode of constructing sluices in places where there is no fall of water, by means of which large ships and their cargoes may be raised to any height within an hour or two, a flying chariot, and many other things, amongst which was "a method of discovering the desires and affections of the minds of men by analogies."

In 1716, Charles XII. appointed Swedenborg Extraordinary Assessor in the College of Mines, and also availed himself of his services as engineer. After the death of Charles XII. he continued his scientific pursuits, and complained bitterly of the neglect which useful novelties then experienced in Sweden. Methods of finding the longitude by means of the moon, observations and speculations in geology, propositions for reforming weights, measures, and currency, so as to facilitate calculation—these were among his studies; and as they brought him no employment, he again took to travelling, writing, and publishing. His revelations of trade secrets in mining and metallurgy being objected to, he replied, that "whatever is worth knowing should, by all means, be brought into the great and common market of the world. Unless this be done, we can neither grow wiser nor happier with time."

Attempting to trace how the physical frame of things began, he assumed motion to have originated in a *point*, which he defined as the simplest existence, and proceeding immediately from the Infinite. This point he described as pure and total motion. By a union or combination of "points," the first finite is derived, having two natural poles formed by the spiral motion of the points, and revolving on its axis. By further combinations he fancied other finites were composed, the

fourth being ether, and the fifth air, and "in a state of still closer compression, water." Water, he thought, according to the erroneous belief of the time, to have no elasticity, and, therefore, he did not regard it as belonging to the elemental kingdom. He says, "It is purely the first material finite. In a globule of water is contained all that had previously existed from the point downwards, like box within box." With these "points" as materials, it was easy to develope a cosmogony, and show how the sun and the planets were produced, and something like the nebulous theory seems to lurk in the expressions cited by Mr. White.

A fundamental doctrine of Swedenborg is that "matter is everywhere the same in great as in little." This he applied in all his cosmical and chemical speculations, and also made it the foundation of his theories concerning spiritual worlds, which he conceived to correspond in almost all their facts and conditions with the lower world of matter and mortal life.

Anatomy and physiology occupied much of Swedenborg's time, and he thought to find the soul in the finest and most subtle tissues of the body. The red blood he supposed to be divided into a purer blood, and a purest, which he called "spirituous fluid," and he described the blood as the most complex of all things, and asserted that it contained "salts of every kind, both fixed and volatile, and oils, spirits, and aqueous elements; in fine, whatever is created and produced by the three kingdoms of the world—the animal, the vegetable, and the mineral." He fancied red blood globules to be composed of white globules, aggregated in sixes round cubes of common salt, and inside the ultimate globules he placed the "animal spirits," imaginary entities generally believed in at that date. From common salt, by truncation of its angles, and various arrangements of its particles, he thought acids and alkalies were formed.

The animal spirits were in his philosophy the vesture or body of the soul, and the soul itself was "a fluid most absolute." Respiration he conceived to be a mode of feeding upon aerial food, in which the lungs sucked ether from the air, and converted it into white blood.

Looking to Swedenborg's scientific attainments, no one can doubt that he was a man of remarkable talent, knowledge, and ingenuity; but there is a wide difference between an inventive man, well stored with the current facts and processes of his day, and a great original thinker and observer in science. Those who claim the latter position for Swedenborg seem to us to exaggerate the merit of his lucky guesses, and to overlook his palpable blunders and absurdities. Although he professed the doctrine that experience was the basis of know-

ledge, he was continually unable to discriminate between what was actually ascertained by means of experience, and what was simply imagined by pursuing a theory to its ultimate results. Modern philosophers have completely given up the vain attempt to know what matter is in its essence. They content themselves with studying its actions and effects, and the doctrine is becoming prevalent that all forces are modes of motion of material particles, whatever such particles may be.

The supposition that mathematical relations of quantity prevail all through nature, from the smallest and subtlest, to the largest and most concrete forms, originated with the old Greek philosophers; and Swedenborg can lay no claim to originating such an idea. That he had glimpses of real laws and truths not recognized in his day, we may fairly concede, but his philosophy was a jumble, in which fact and fancy, rationality and delusion, were mixed.

He united, to a degree seldom witnessed, the opposite faculties of acquiring extensive and accurate knowledge in experimental and observational sciences, and of being under the influence of dreams and hallucinations, during the continuance of which scientific principles of verification were freely abandoned. His mind was remarkably inventive, and when not engaged in endeavouring to make new applications of physical science, he invented in the realms of social, psychological, and theological speculation. He stands alone amongst the mystics for extensive acquisition of positive knowledge, and for zeal in its diffusion. The oriental mystics lost sight of earth, in their imaginary contemplations of heaven—Swedenborg always had an eye to the practical, and his speculations were intended, and often did tend, to the improvement of mankind.

The place assigned to Swedenborg as a scientific man will vary with the notions of what constitutes discovery, which his critics or admirers entertain. Most important discoveries have been imperfectly shadowed forth in the sayings or statements of those who did not know how to give them a definite and enduring shape; and, perhaps, no clever man, in any age of the world, has ever speculated much upon difficult problems, without sometimes coming near truths reserved for later thinkers to see more clearly and unfold. In mechanical invention how many thousands get a vague notion of what ought to be done, but fail to discover how to do it. It is the same in speculative science, and he only ought to be held as a discoverer who leaves his work definite, intelligible, and complete. If Sweden had offered more scope for the engineering and metallurgical talents of Swedenborg, his career might have been materially changed, and instead of being the mystical prophet of a small though important sect, his visions might have wandered less

freely through imagined realms of spirits, and have been chiefly confined to regions in which his statements could be tested, and his alleged facts subjected to proof.

From his father, Swedenborg inherited what he took for the faculty of spirit intercourse. "From his childhood, when on his knees at prayer, his breath was curiously holden within him; strange rays of light, from the sun of another country, from time to time had broken in through his darkness." These words are his biographer's, but he tells in his own, how flames of various colours appeared to him while he was writing one of his books, as evidences of the truth he was recording; and "this was before the spirits began to speak with him as man with man." The development of the visionary faculty took place at a comparatively late period of his life, and is placed by Mr. White as lasting from his fifty-fifth year to his death at eighty-five.

In 1858 a small volume was offered for sale to the Royal Library at Stockholm. It proved to be a diary kept by Swedenborg between 1743 and 1744, and the extracts cited by Mr. White show that he passed through well-known stages of religious madness. A sense of desolation was experienced, though in a mild form; but soon, he says, "all was heavenly, clear at the time, but inexplicable now. In one word I was in heaven and heard speech, that no tongue can utter, nor the glory and the innermost delight which followed this speech." He next believed that Jesus Christ appeared to him in person, and in the whole of his subsequent life he believed himself to be a divinely chosen instrument for conveying religious truth to man. As a curious instance of his mode of interpreting his visions, we find this entry.

"Dr. Morsus appeared to be courting a handsome girl, and she allowed him to do with her what he liked. I joked with her because of her easy consent. She was a handsome girl, and grew taller and prettier. This means that I should obtain information and meditate about the muscles."

In London he appears to have gone quite out of his mind, stripping himself naked, and rolling in a deep, muddy gutter, but he did not remain in this condition, and was soon able to take care of himself, and act rationally until his death, though seeing visions, and receiving spiritual visitants nearly the whole time. Returning home he resumed his official duties, and employed his leisure in learning Hebrew; but believing himself to have a divine mission, he soon resigned his assessorship, and devoted the rest of his life to theological pursuits.

The theological career of Swedenborg could only be fairly traced in connection with the history of religious thought.

His followers consider that the reality of his alleged visits to heaven and hell, and the truth of his opinions are shown by the force of internal evidence. No one doubts Swedenborg's veracity or honesty, and those whose minds impel them to accept his system as a matter of faith, find no difficulty in believing that he was favoured above other mortals with a spiritual insight. Others, while admitting that his multitudinous writings contain many beautiful and true ideas, see no reason for entirely separating his case from thousands of others, in which cerebral disorder has existed, and given rise to analogous hallucinations. We do not intend to discuss or describe his theological views. They are tolerably well-known, and his followers circulate them abundantly in tracts and publications easily obtained. One very fine thought occurs in his delineation of the spirit worlds, which he conceives to be untrammelled by limitations of space. Nearness of mind and heart, according to his philosophy, cause spirits to appear in each others presence, and no physical journeying is necessary to bring together those whom active love and sympathy unite. As a rule his statements concerning heaven and hell are nothing more than ingenious applications of the notion that terrestrial existence is the type of all existence. Joys and pains, temptations, clothes, houses, etc., etc., are, according to his descriptions, much the same in the spirit worlds as on earth, and it is difficult to understand how any one can see in such delineations proof of anything more than an ingenious constructive faculty, acting more or less under the stimulus of cerebral disease.

Great stress has been laid by some on Swedenborg's apparent knowledge of events not within the reach of ordinary faculties to discover. For example, at Guttenburg he is reported to have described a fire then raging at Stockholm, 300 miles distant, and after appearing to watch the progress of the flames, he exclaimed, "Thank God, the fire is extinguished the third door from my house;" which proved to be correct. A few other stories of an analogous nature are handed down with evidence of authenticity more or less complete. Such narratives are, no doubt, puzzling. They belong to a very numerous class; and in all ages visions, dreams, and presentiments have occasionally proved true. To affirm that such cases cannot possibly be more than chance coincidences would be to assume a knowledge we do not possess, while to maintain that they are proofs of supernatural agency is to invent an explanation not warranted by the evidence.

Those who wish to know more of Swedenborg will do well to consult Mr. White's volumes, which contain much curious matter, and furnish specimens of his writings on various subjects.

We should have recommended Mr. White to have employed a more dignified tone in some of his controversial remarks; but he has, on the whole, produced a work that exhibits unmistakeable marks of industry and research, and will enable Swedenborg to be better understood by general readers than heretofore.

ARCHÆOLOGIA.

At a recent meeting of the British Archæological Association, on April 10, a number of FORGED ANTIQUITIES were exhibited, differing in many respects from the forgeries in lead and cock-metal from the manufactory in Rosemary Lane, to which we have now been so long accustomed. This new class of forgeries seems to have made its appearance about the month of November last, and the articles are usually represented as having been found at Brooks's Wharf, Queenhithe. The objects produced on this occasion were all made of zinc, and had been washed or dirtied so as to give them an appearance of age. The first was a small kneeling figure holding an open book, evidently copied from some one of the plaster casts commonly hawked about the streets, but with the addition of a nimbus. Another was a small vase, or ampulla, bearing a figure of St. Barbara; and this same figure is repeated on a brooch pretended to have been discovered in January last. There was also a pin in the shape of a sword, four inches long; a gauntleted hand and arm, as if broken off from a statuette; a small label inscribed "Amurs," intended to appear as if it had formed the foot-rest of a small effigy; another small ampulla; two horn-shaped vessels about four inches long; a brooch in form of a helmet; another gauntleted arm; a small gauntlet, and a right leg incased in armour, having the look of a part of the Manx arms. Several of these articles are furnished with rings, to give them the appearance of having been worn as personal ornaments. A very prevailing form of ornament upon them consists of pellets arranged in rows, circles, and other devices.

Mr. Ecroyd Smith has sent us a copy of his *Notabilia of the Archæology of the Mersey District*, in which he gives a much more complete account of the ANTIQUITIES found of late years on this part OF THE CHESHIRE COAST than in the report published in the *Reliquary* from which we gave some notes in our last. We were ourselves led into error, it appears, in an important circumstance in regard to these antiquities. They are not, Mr. Smith informs us, "washed up" on the beach. "They are washed *out*, and often *down*, but never *up*. Thousands lie in all probability buried under the Great Hoyle Bank far extending to the eastward, and over the site of the early settlement or village." It appears that there was here anciently a promontory, on which the Romans formed a settlement, and which was subsequently occupied by Saxons and Normans; it was known in the middle ages by the name of the Meols; but

the sea has for centuries been gradually gaining upon it, until now nearly all that remains above water consists of a sand-bank at some distance from the shore. In his pamphlet, which is a reprint from the *Transactions of the Historic Society of Lancashire and Cheshire*, Mr. Ecroyd Smith has given interesting sections of the present coast, showing the different strata of deposit, which represent different periods, Roman, Saxon, and Mediæval, with an indication of the class of objects found in each. Perhaps one of the most interesting discoveries recorded here by Mr. Smith, is that of a number of leaden pans, undoubtedly of the Roman period, found at a depth of ten feet near the bank of the river Weaver, at Northwich in Cheshire, and first announced to the public by Dr. Kendrick, of Warrington. They were no doubt used by the Romans for boiling the water to extract salt; in fact, Roman brine-pans. Northwich, like most of the places with names in which this syllable *wich* enters, such as Nantwich and Droitwich, are nearly always sites occupied by the Romans for salt-making, and Dr. Kendrick suggests that this may have been the Roman *Salinæ*, which others have placed at Droitwich; but there may have been several places to which the Romans gave this same name. These brine-pans furnish an interesting illustration of the manner in which the Romans in this island manufactured their salt. It is a curious fact that in early mediæval charters connected with Droitwich, the brine-pans are termed *plumberia*, indicating that they were made of lead, and a certain number of them are stated to have constituted a *bullerium*, or boiling. All these discoveries are of very great importance to the physical and moral history of the district, and too much praise cannot be given to Mr. Ecroyd Smith for the zealous care with which he has collected and recorded the facts.

We are glad to be able to announce that the town of Liverpool has decided on rendering an honourable act of justice to the name of one of its most eminent and distinguished townsmen, to whom, among many other benefits, it owes the gift of a noble museum of antiquities (which has just been removed into the building newly destined for its reception), by erecting a STATUE TO JOSEPH MAYER. It is to be executed by Signor Fontana, who is now, we believe, at Liverpool, engaged upon it, and to be placed in St. George's Hall.

A remarkably interesting discovery of ROMAN SEPULCHRAL REMAINS has recently been made in a field between Silsby and Barrow-on-Soar, in the county of Leicester, about three miles westward of the fosse-way running from *Ratæ* (Leicester) to *Lindum* (Lincoln), and six miles north of the former town. The accidental excavations to which we owe this discovery appear to have extended over part of a regular Roman cemetery, which contained above a dozen separate interments, and furnished a certain number of objects, which have been presented to the Leicester Town Museum. We have before us a beautiful photograph and a lithograph of the greater part of these objects, and a plan of the site of the excavations, with the places marked on which each object was found. Among the latter were no less than five large wide-mouth glass vessels, which contained burnt human bones, each taken from a separate interment. Four of them were rectangular, or four-

sided, and the fifth was six-sided, and one had two handles. One was found inclosed in a chest of limestone. Only one clay cinerary urn was met with; but in one grave was found a large, almost globular, amphora, two feet six inches in height, and two feet in diameter, computed to hold fifteen gallons, which had perhaps been used as a sepulchral urn, for it was found in a fragmentary state. It should be added that the mouths of two of the glass vessels were almost hermetically sealed with lead. Near the limestone cist containing one of the glass vessels were found together two iron lampstands, with the iron moveable rods attached, by which they might be suspended to a wall. They had perhaps been used to support lighted lamps in a small sepulchral chamber or cist, and lamps have been found not unfrequently under similar circumstances in Roman interments in our island. Among other fragments was a piece of a vessel made of the red glazed pottery, which our antiquarians seem now agreed in calling Samian ware. Besides these interments of burnt bones, there were found five skeletons, the remains of bodies which had been buried entire. It is evident from many similar discoveries, that the two practices of cremation and burial of the body entire prevailed in Britain during the whole Roman period, and that the adoption of one or the other was a mere question of individual choice. After the second century, the practice of burning the dead began rapidly to be discontinued in the south, until it disappeared entirely under the Christian emperors. But it is probable that the influence of the imperial laws and regulations in such matters as this extended but slowly into the distant provinces; in the more fashionable parts of Roman Britain we find both modes of interment intermixed in the same cemetery, while, as we approach what must have been the remote districts, the burial of the body entire occurs less frequently. In the cemeteries at Wroxeter, the Roman *Uriconium*, a very large town, which was not destroyed till the very close of the Roman period, down to the present time no single instance has been found of burial otherwise than by cremation. The ashes of the dead were usually deposited in an earthenware vessel, generally of a form which was no doubt made for this peculiar purpose. Sometimes, when they were perhaps made in a hurry, for the necessity of the moment, in localities where they were not always to be had ready made, they are of very rude and imperfect work. The glass vessels used for this purpose are less common, and, as they are usually of very good material and workmanship, they were, probably, only used by people of a superior class. We may suppose that this cemetery at Barton-on-Soar belonged to people of a superior position in society, who not only used glass vessels for interment when they still practised cremation, but who had adopted to a considerable extent the more fashionable mode of burying the body entire. The urn itself, whether of earthenware or glass, was sometimes buried, as here, in a cist or coffin; and sometimes, as we have found in many instances in Britain, it was placed within an amphora, the upper part of which had been skilfully broken off to allow of the urn being put inside. We are informed that the amphora found at Barton-on-Soar had been filled with charred wood, among the remains of which were found large nails;

these globular-shaped capacious amphoræ are not common. An instance of one used, probably like this, for inclosing the ashes of the dead, was found at Colchester some years ago. In a grave in the Roman cemetery at Cirencester (*Corinium*) an urn receptacle was found, which appeared to have been one of the stones of a cylindrical column, sawn in two, a hole made in the centre to receive the urn, and then the two parts united again. In the middle of this cemetery opened at Barton-on-Soar was found a square area covered by a rubble floor, which no doubt served some important purpose connected with the burial place.

While speaking of Roman interments, we may state that two Roman leaden coffins have recently been discovered near Milton-next-Sittingbourne in Kent, one containing the skeleton of a female, the other that of an old man. It is said that, when first opened, a white beard, descending to the breast of the latter, was distinctly visible. One earthern and two glass vessels were found accompanying it. These leaden coffins of the Roman period are found rather frequently in Britain. Perhaps they belong to a rather late date, as, in at least one instance, an interment in a leaden coffin, evidently in the Roman manner, has been found in an Anglo-Saxon cemetery, as though the practice had continued after the close of the Roman period.

T. W.

PROGRESS OF INVENTION.

New Source of the Tanning Principle.—Notwithstanding all our improvements in arts and manufactures, it may still be said, with truth, that "there is nothing like leather." This valuable substance has often been imitated, but it has never been superseded, and probably never will. To facilitate and cheapen its manufacture is, by consequence, a matter of considerable importance. The tanning principle obtained from vegetables is more or less limited in supply, and therefore costly; and a natural attempt to economize it results but too often in the production of an inferior leather. Artificial tanning has been proposed, but as it has hitherto been best obtained from resin, it also is expensive. Recent experiments have shown that it may be formed with great facility, and at a trifling cost, from bituminous coal or lignite; the latter answering best on account of its permeability by liquids, a property of some importance from the nature of the process employed. This consists merely in heating the coal or lignite for a considerable time with nitric acid, and then evaporating to dryness. The residuum, a dark brown substance, is entirely soluble in alcohol, ether, concentrated sulphuric acid, the alkalies, and their carbonates; but it consists of two portions, one of which only is soluble in water, the solution having an acrid and bitter taste, and being capable of precipitating albumen and gelatine. Should it be found an efficient substitute for the tanning principle of vegetables, which is not unlikely to be the case, the cheapness and abundance of the source whence it may be obtained will considerably affect the economic production of leather.

Peculiar Application of Electricity.—The brilliancy of the electric spark very soon suggested it as a means for obtaining artificial light, and numerous experiments were made with the object of utilizing it in that way. These experiments, though not altogether unsuccessful, led to no practical results. Among the difficulties experienced in the application of machine electricity to the purposes of illumination, one of the most serious was the impossibility of obtaining perfect insulation. This does not exist to the same extent with galvanic electricity, and hence the application of this form of electricity to illuminating purposes has been attended with better success; and the improved modes of producing it, and other forms of that agent having a controllable intensity, has given an impetus to the efforts of those who count on the application of the electric light to practical purposes. One of the most curious instances of this application is, perhaps, that recently made in Paris for the production of theatrical effect. Light metallic crowns, having slight interruptions, were worn by some of the performers; and when the galvanic current from a concealed battery was transmitted through these crowns, brilliant stars of light were produced at the interruptions. The most costly diamonds would not have afforded an equally brilliant effect. The danger of so powerful an agent as a strong galvanic current in the hands of the inexperienced or the neglectful, was illustrated, at the same time, by the fact that one of the performers was seriously injured, the head having been allowed to form a part of the circuit.

Sonorous Vibrations, a Means of Measuring Minute Portions of Time.—An apparatus recently perfected by M. Niaudet-Breguet affords a simple means of measuring, with ease, extremely minute portions of time. In its earlier forms, this apparatus was employed only to record graphically the vibrations of sonorous bodies. It originally consisted of a tuning fork, on one branch of which was fixed a point, that, when the fork was set in vibration, described a sinuous line on a cylinder covered with lamp black, and made to revolve by clock work. To render the vibrations continuous, instead of lasting but a very short time, each branch of the tuning fork was alternately attracted by an electro-magnet, which was placed very near it, and which was, at suitable intervals, placed in connection with a galvanic battery, by means of the apparatus usually employed for making and breaking connection with the ordinary induction coil. The apparatus was so arranged that the sound produced by the apparatus for making and breaking contact was in unison with, or some octave of that of the tuning fork; which was effected by turning the regulating screw.

The next improvement introduced into the apparatus, was the substitution of one of the branches of a tuning fork, having a pitch corresponding to the tuning fork attached to the apparatus for graphic delineations, instead of the vibrating metallic slip, used with the induction coil.

M. Niaudet-Breguet's improvement consists in the use of an horological instrument, in which the pendulum is replaced by a tuning fork; the movement of the wheel work being controlled by

the vibrations of the fork, and the vibrations of the fork being rendered continuous, by means of the impulses derived from the wheel work. Hands and a dial indicate the velocity of vibrations. The tuning fork constituting the pendulum being connected with that of the apparatus for graphic delineations, and made to correspond with it, as to pitch, the dial will tell the number of vibrations made by the tuning fork of the recording apparatus. Tuning forks of various pitch may be used with the horological apparatus, since their rates of vibrations are not affected by the intensity of the moving power. Or one tuning fork may be regulated to different pitches, by symmetrical and equal weights, which are made to slide along the branches. For small changes, screws fixed in the branches, and moving in and out parallel to the axis of the fork will afford a sufficient power of regulation.

This instrument enables us to measure very minute intervals of time, to regulate the velocity of the movements communicated to astronomical instruments, and to obtain synchronism between two apparatus, at considerable distances apart, and notwithstanding great variations in the intensity of the motive power, a matter of great importance in telegraphy.

Application on Sulphuret of Carbon to the Preparation of Perfumes.—The ordinary tedious, and wasteful mode of obtaining odoriferous principles from flowers, is likely to be superseded by one far more simple. It consists in an application of the affinity which the sulphuret of carbon has for these principles. A flask containing the petals of flowers recently gathered, having been filled up with the sulphuret is corked and shaken. It is then left at rest for about six hours, after which, the sulphuret being decanted into a flask containing the petals of similar flowers, it is corked, agitated, and left to rest as before. The same thing is done with a third and a fourth flask of petals. The sulphuret will then be found deeply coloured, and floating on the water which it has driven out from the pores of the flowers. Having been separated from the water, if the quantity is small, it may be evaporated by mere exposure to the air, and the residue treated with alcohol. Or it may be mixed with oil of sweet almonds, then shaken several times a day for three or four days, and afterwards placed in an open vessel and exposed to the air. If the mixture of sulphuret and oil of sweet almonds is considerable in quantity, it should be distilled at the lowest sufficient temperature, in a water bath. Were the temperature allowed to become too high, some of the sulphuret of carbon would be lost, and some of the aromatic matter destroyed. Equal parts by weights of petals and sulphuret, and a little more than one-third of the weight obtained of the petals oil, are very suitable proportions. The perfumed oil in this way answers well for every purpose requiring the use of aromatic essences.

Simple Mode of Gilding Porcelain.—A bright coating of gold, without the use of the burnisher, may be produced on porcelain by very simple means. For this purpose two compounds are first to be prepared. The first is formed by dissolving thirty-two parts gold in aqua regia formed with equal quantities nitric and hydrochloric acid,

and then adding to the solution one-fifth part tin and one-fifth part butter of antimony, and, after the application of heat, diluting with five hundred parts water. The second compound is formed, by gently heating sixteen parts sulphuric acid, sixteen parts Venice turpentine, and thinning the uniform dark brown mass thus obtained with fifty parts oil of lavender. The two compounds are to be mixed and well stirred, heat being applied, until a uniform liquid is obtained. The water and excess of acid separates, on cooling, from the resinous mass, which having been well washed with water, and then freed from moisture, is to be thinned by the addition of sixty-five parts oil of lavender, and one hundred parts oil of turpentine, the perfect incorporation of the constituents being hastened by heat. Five parts basic nitrate of bismuth are now to be added to the resulting uniform mass, and after the mixture has been allowed to rest, the clear portion is to be poured off. This is the material used for gilding. It is applied to the porcelain in any convenient way, and dries very quickly. After the porcelain has been subjected to a high temperature the gilded portions are very brilliant.

New Textile Fibres.—There are many plants found in great abundance, that would furnish large quantities of excellent textile fibres, were it not found extremely difficult to separate them from the woody portions. It has been found that this difficulty may be overcome by very simple means. The stalks are first to be passed between rollers for the purpose of disaggregating them. Having then been placed in a vessel containing a very weak solution of commercial soda, steam, having a pressure of four or five atmospheres, is to be passed into the solution, which is to be kept at a boiling temperature for a time, which varies with the nature of the plant. The yellow brown cellulose thus obtained, is to be washed with water, to which a small quantity of hydrochloric or sulphuric acid has been added, to neutralize any alkali that may be present, and is then to be placed in any bleaching fluid. When removed from this, to prevent colorization being again produced, it is to be washed in any extremely dilute solution of carbonate of soda, and is then to be left in a weak solution of chloride of lime. The brown colour first produced by this latter treatment, is succeeded by a brilliant and permanent whiteness.

Panoramic Photographs.—Very simple means have been recently devised for producing panoramic views of almost any extent with the ordinary camera, and the results thus obtained are such as leave nothing to be desired. For this purpose the camera is made to revolve on a centre, the positions to be given to it in succession being indicated by a graduation on the plate upon which it rests; and the glass plate is made to slide in a groove, so that different portions of it may come successively into the required position behind the objective, the proper changes of position being indicated by notches. Such an arrangement will, it is evident, in theory, secure the desired effect; but in practice it is, as might be expected, found, from the impossibility of making the boundary of one part of the view exactly to correspond with that of the succeed-

ing, that the union of both is indicated by a line, a circumstance quite sufficient, if irremediable, to render the contrivance inadmissible. This difficulty is, however, easily obviated by the use of a suitable diaphragm placed within the camera at a proper distance from the objective and the glass plate. There is thus produced a kind of penumbra in one position, which is rendered perfect by exposure during the next position. The impressions corresponding to the successive portions of the view being in this way made to blend with each other, so that no line of demarcation between them can be perceived. Five or six movements of the camera and the plate are found quite sufficient for a very extended view.

Application of Air charged with Combustible Vapours.—Inflammable gases are frequently rendered capable of imparting a more brilliant light, during combustion, by charging them with hydrocarbon vapours. Experiments are, however, being made at present in Russia with atmospheric air charged with these vapours, and the result is said to be the production of a combustible gas capable of affording a heat sufficiently intense to melt steel. Atmospheric air is forced through oil of turpentine, and carries along with it an amount of the fluid sufficient to cause, during its combustion, not only the evolution of an intense heat, but the emission of a clear and brilliant light. It is intended, in this way, to provide fuel for some small steamboats which are intended to run on the Neva. Such an arrangement may be found convenient, and even economical, in certain circumstances; but if it is used, it will be necessary to guard against the danger of explosion. This, however, may be done by very simple means.

Miscellaneous.—*New Application of Photography.*—Photography now enables us to obtain the picture of a projectile passing out of the mouth of a gun. For this purpose it is necessary to have a coldion which requires a very short exposure, and a means of rendering the exposure and the ignition of the charge perfectly simultaneous. The latter, which would be impossible to any degree of manual dexterity, is effected by very simple and infallible means. The current of galvanic electricity which by rendering a thin platina wire incandescent, explodes the charge, excites an electro-magnet that raises a disc from the front of the lens of the camera. When the wire has melted, that is, when the ignition of the charge is complete, the disc falls in front of the lens.——*Reinforcement of Photographic Negatives.*—A negative may be imperfect from insufficient exposure, in which case the details will not be well brought out: or from the collodion, the silver bath, or the developer being out of order, in which cases it will not be sufficiently opaque. The former imperfection may be removed by means of pyrogalic acid, to which has been added citric acid and a few drops of aqueous solution of nitrate of silver. The latter, by means of, first, an aqueous solution, containing three per cent. of chloride of copper, then washing with water, applying an aqueous concentrated acid solution of sesquichloride of iron; again washing, then applying an aqueous solution of iodide of potassium, which has been saturated with pure iodide of silver, and finally washing. If

both defects are present at once, the two remedies must be employed in succession.——*Estimation of Silex in Wheat.*—It has long been known that silex is a necessary constituent of the wheat stalk, a deficiency of it leading to a tendency in the wheat to be easily overthrown by wind or rain; hence the application of siliceous manures. On the other hand, it has been found that wheat-straw containing even more than the normal amount of silex is liable to the danger of being prostrated. M. Isidore Pierre has enabled us to reconcile these apparent contradictions. The silex is found in very different quantities in the leaves, the knots, and the spaces between the knots—the leaves containing, for a given weight, far the largest quantity. The more luxuriant the leaves, therefore, the greater the amount of silex, but the greater also the weight to be borne by the stalk; and the less capable it is of bearing it, being hindered from becoming dry on account of the free access of air being prevented. The errors on this subject have, therefore, arisen from estimating the silex as a whole, and not considering by itself the portion found in the stalk. Not that the entire of what is found in the leaves is ineffective: for a part of the leaf is in the form of a sheath, which adds to the strength of the stem. But this sheath is not proportionately increased when the leaf becomes very luxuriant. Weight, therefore, but not at the same time strength, is added, when the leaves are greatly developed. Hence the advantage sometimes found in thinning the leaves before the ear begins to form.——*Water-proof Cement.*—It has been found that the addition of coal-dust to ordinary cement renders it completely water-proof, and imparts to it great solidity. For this purpose two parts of fine cement, one part coal-dust finely pulverized, and one and a half parts slaked lime, may be used, the whole being brought to a proper consistency by the required amount of water.——*Sensitive Litmus Paper.*—We have given an extremely sensitive test for acids; but as litmus paper is, in ordinary circumstances, very convenient, it is desirable, if possible, so to prepare it as that it may be relied upon. This is easily done. It is highly sensitive only when its colouring matter consists of the red principle of the litmus, combined with subcarbonate of potash. Any substance having a greater affinity for the red principle than the potash will decompose it. Commercial litmus paper often contains the red principle, united with subcarbonate of lime, instead of subcarbonate of potash, a compound decomposed with considerable difficulty. To prevent the presence of the calcium compound, the paper should, before the application of the colouring matter, be immersed in a weak solution of hydrochloric acid, which removes the lime, and thus secures the production of a test paper containing only the highly sensitive compound.

PROCEEDINGS OF LEARNED SOCIETIES.

SOIREE OF THE ROYAL MICROSCOPIC SOCIETY.

The annual *soirée* of the Royal Microscopical Society was held at King's College on the 24th April; James Glaisher, Esq., F.R.S., the President of the Society, receiving the company, which was unusually numerous, and of a distinguished character. The supply of microscopes was very large, and the objects of greater variety and interest than usual. Mr. Sorby exhibited his excellent plan for comparing the spectrum of any object under the microscope with a standard absorption spectrum, obtained by transmitting light through quartz of a given thickness. Mr. Browning showed the same apparatus, carried out as devised by Mr. Sorby. Mr. Sorby likewise exhibited his dichroiscope, a new instrument for the examination of crystals, to which we shall revert on another occasion. Mr. Ross and Mr. Baker exhibited Mr. Slack's adjustible diaphragm for eye-pieces. Messrs. Powell and Lealand showed their binocular arrangement for high powers. Mr. Baker showed a variety of new apparatus, including his travelling microscope. Mr. Highley showed waistcoat-pocket and other portable microscopes, a new hydrocarbon demonstrating lantern, for exhibiting objects on a screen, etc. Messrs. Murray and Heath brought a new pocket microscope, and other useful novelties. Prof. Smith's mechanical finger was shown by Mr. Bailey, and by Mr. Browning in a simplified and economical form. Among the most important objects were a beautiful series, shown by Dr. Carpenter, illustrating the development of the comatula, from its pentacrinoid larva; Mr. Whitney's preparations, showing the development of the breathing apparatus of the tadpole; the structure of the hyalonema, and its encrusting polyps, by Mr. C. Tyler; some new and rare forms of rhizopoda, etc., obtained by Major Owen, by surface-skimming of the mid ocean; a diamond, containing an appearance of organic structure, by Mr. W. H. B. Hunt, etc., etc. Mr. Norman brought a very fine series of objects, and the tables of Ross, Powell, R. and J. Beck, Baker, Pillischer, How, Crouch, Collins, etc., were very attractive. In the course of the evening, Mr. Highley exhibited, with the oxyhydrogen lantern, some beautiful views of scenes in Australia and Africa, lent by Mr. Baines. The picture of the Victoria Falls of the Zambesi was much admired, and a view of that remarkable plant, the *Welwitchia mirabilis*, attracted great attention. In a living state the leaves are of a beautiful green, and like enormous ribbons stretching along the ground, while the flowers are fine red. Altogether, this *soirée* was the most successful that the Society has given.

LITERARY NOTICES.

Handbook of Astronomy, by Dionysius Lardner, D.C.L., formerly Professor of Natural Philosophy and Astronomy in University College, London. Third Edition. Revised and Edited by Edward Dunkin, F.R.A.S., Superintendent of the Altazimuth Department, Royal Observatory, Greenwich, with illustrations on stone and wood. (J. Walton.)—The plan of this work is to give first brief descriptions of methods and instruments, then to describe the earth, the moon, the tides and trade-winds; then to pass to the sun, the planets, comets, and fixed stars. Thus a large range of subjects is included in a comparatively small well-printed work, which contains the kind of matter required by general students. The illustrations are very numerous, and generally good; but those of nebula and clusters cannot be commended, and must be taken with large grains of allowance; that, for example, of the Great Orion nebulæ would scarcely be recognized by any one acquainted with its telescopic appearance. The chapter on the sun required more revision than it has been subjected to, and it is somewhat absurd on turning to "Stellar Clusters and Nebulæ," to find the latter spoken of as all resolvable if sufficient telescopic power were employed. Some defects of this description are corrected in an appendix; and, on the whole, the new edition may take its place among the useful manuals of the day.

The Electric Telegraph, by Dr. Lardner. A new Edition, Revised and Re-written by Edward B. Bright, F.R.A.S., Secretary of the British and Irish Magnetic Telegraph Company. With 140 illustrations. (James Walton.)—An interesting volume well brought down to date by its editor, and containing in a small compass a large quantity of important matter. We should have recommended the disuse of such a phrase as "the electric fluid is deposited in a latent state in an unlimited quantity in the earth," etc. Electric science certainly knows nothing of deposits of electric fluid, though the phrase may be excusable in newspaper paragraphs; and the deposition of fluid in latent state sounds absurd, unless it were a slang periphrasis for hiding a barrel of beer. There are many other passages to which objections might be taken, but, on the whole, it is a good popular work.

A Dictionary of Science, Literature, and Art, comprising the Definitions and Derivations of the Scientific Terms in General Use, together with the History and Description of the Scientific Principles of nearly every branch of Human Knowledge. Fourth Edition, Reconstructed and Extended by the late Dr. T. Brande, D.C.L., F.R.S.L. and E., of Her Majesty's Mint; and the Rev. George William Cox, M.A., late Scholar of Trinity College, Oxford, assisted by Contributors of Scientific and Literary acquirements. (Longmans, Part xii. April, 1867.)—This number is a very thick one, commencing with Sigurdh, and ending with Zymotic, thus closing the work. We have very often expressed our opinion of this work. On the whole it is well done, and calculated to serve the ordinary requirements of educated families. The subjects of the articles are

well selected, and they are for the most part well written. The weak part is the natural history and microscopy. Physics, chemistry, astronomy, music, and a host of other subjects, are judiciously treated, and the general promise of the prospectus fairly carried out.

LIGHT; ITS INFLUENCE ON LIFE AND HEALTH, by FORBES WINSLOW, M.D., D.C.L. Oxon. (Hon.), etc., etc. (Longmans).—Dr. Winslow's work is popular rather than scientific. It is pleasantly written, and well adapted for family reading. The chapters on the supposed influence of the moon on disease, and especially on insanity, contain much important evidence in favour of ascribing such action to our satellite, but such a subject requires much more elaborate and scientific treatment than Dr. Winslow has given to it. With the very common tendency of diseases to periodicity, it would be expected that in a great number of instances their times of diminution or increase would coincide accidentally with the periods of any regularly recurring series of events. For example, the tides ebb and flow at fixed intervals, and it is a very common popular belief that the ebbing of the tides influences the termination of human life, and creates a period of maximum death. Now in a populous country nothing could be easier than to obtain an immense number of instances in which death paid its visits as the waters flowed away; but a more complete analysis would dispose of the theory by exhibiting numerous instances of its failure. In like manner, a doctor having a lunar theory will readily find apparent confirmation, but another doctor not possessed with such a theory would discover abundance of facts that did not coincide with it. The influence of the moon on the weather has been a prevailing belief in all centuries and ages, and yet how very few propositions affirming such action can be considered as at all substantiated. The moon may influence weather and may influence disease in more ways than one, but its influence may be so mixed up with other influences as to be difficult to disentangle, and by no means sure to dominate. It is rather surprising to find a physician of Dr. Forbes Winslow's standing citing with approbation the nonsensical remark of Mr. Steinmetz that sunshine consists of a *metallic shower* because the solar photosphere appears to contain incandescent metallic vapours. The ascription of physiological effects to the "iron vapour" of a sunbeam is more comical than scientific. In the first place there is not a particle of evidence that the sun sends us through his beams a supply of iron from his own body, and in the next place if a sunbeam were imagined to contain iron at all, the quantity would put to shame the infinitesimal doses of the homœopathists, at which Dr. Winslow would, no doubt, laugh. Sunbeams are *practically* imponderable in the finest balances, though if we conceive them as a motion of particles, the particles *may* have weight, though to an inappreciable extent. A great mass of concentrated sunbeams weigh *nothing*, or nothing appreciable, and yet they may contain iron enough for a medical dose! We hope Dr. Winslow will never overdose a patient after such a theory of infinitesimal action.

THE NORTH-WEST PENINSULA OF ICELAND; being the Journal of a

Tour in Iceland in the Spring and Summer of 1862. By C. W. SHEPHERD, M.A., F.Z.S. (Longmans.)—An elegant little book, with two coloured plates of Icelandic scenery, and containing a readable narrative of exploration into parts of the island which have escaped previous tourists. The picture of the hardships to be endured by travellers among the hospitable, but poorly provided Icelanders, is not very inviting, and agrees substantially with the experience of other travellers. Scattered through the work are many interesting illustrations of the physical geography of the island, and of the effects of its severe winters. Of a valley near the Dranga Jökull, the writer remarks, "No place could show the awful effects of the breaking-up of an Icelandic winter more than the valley before us. It was itself a deep ditch with mountain walls. Through the centre ran several broad glacier streams, white and rapid, intersecting one another in every possible manner and direction. Huge snow-drifts also climbed the mountain sides, and large masses of rock and earth were strewn about, having descended from the heights above. One mass in particular drew our attention. We saw it long before we reached it, and thought it was a house in the distance. It had bounded into the centre of the valley, and was so strongly held together by the turf upon it, that it remained unbroken, and presented the shape of an arch with a span of ten feet, and would almost admit of my walking under it." The account of an eider duck island is likewise very interesting, and the book will well repay perusal.

NOTES AND MEMORANDA.

DEVITRIFICATION OF GLASS.—M. Clemandot has a paper in *Comptes Rendus* in which he states that desiring to make a very simple and very dispersive crown glass, he used silica and soda exclusively, without any lime, and with great excess of the first material. While in complete fusion at a high temperature he withdrew a portion of the glass which remained unchanged for ten years, but the mass left in the crucible underwent devitrification as it cooled. He adds that glass is most solid and most unalterable when it contains the greatest number of bases in its composition, but that an excess of any material leads to devitrification.

VARIATION OF SPECIES.—M. C. Dareste brings before the French Academy an instance of the progeny of a hen near Lille resembling the so-called *Poules de Padoua*, as Polish fowls are improperly called. Two chickens, which died before they were hatched, exhibited the peculiar protrusion of the brain between the frontal bones, which characterises this breed, although no trace of its having been at any time crossed with the Lille fowls could be discovered. In another case a cow and calf assumed the characters of a bovine race of South America, the *nata*, or *niâta*, which had a peculiarly short dog-like head, and which seems to have completely disappeared. Several other cases are mentioned in the same paper.

HUGGINS ON THE SPECTRUM OF MARS.—Mr. Huggins' paper in *Monthly Notices* shows that the C line in the solar spectrum exists also in the spectrum of Mars. A strong line distant from C, at about one fourth the distance from C to B, which does not exist in the solar spectrum, was satisfactorily determined. Faint lines were seen on 14th Feb., on both sides of D, similar to those which appear when the sun's light traverses the whole of the atmosphere, and which were in like manner to be produced by the atmosphere of Mars.

MR. BROWNING'S SUN SCREEN.—Mr. Browning has adopted a modification of Foucault's proposal to silver an object-glass by Liebig's process, and view the

sun through the transparent metallic film, which diminishes the light, and prevents the heat reaching the eye. He has used with success a carefully prepared flat disc of glass, silvered on one side, and placed at the mouth of his silvered mirror reflectors. With such an apparatus, applied to Mr. Barnes' $8\frac{1}{2}$-inch telescope, he observed the eclipse of March 6, and saw the mountains on the dark margin of the moon beautifully projected on the luminous disc behind, the protuberances on the S.E. being most prominent. He also noticed that the minimum temperature was not attained in Mr. Barnes' garden (Camden Road, N.W.) till half an hour after the maximum of the eclipse.—*Monthly Notices.*

Brooke on Electric Energy.—An important paper by Mr. Charles Brooke, F.R.S., will be found in the *Proceedings of the Royal Society*, No. 91, the gist of which is that light, heat, electricity, etc., are modes of motion of the particles of matter, and not of an imponderable ether filling up the interstices of matter. He supposes that space is filled with a highly attenuated, but still ponderable substance (ether), which transmits light and heat which is not miscible with our atmosphere any more than oil is with water, but floats upon it. Copper will transmit electricity at the rate of 250,000 miles a second, and other appropriate kinds of matter may in like manner transmit light and heat.

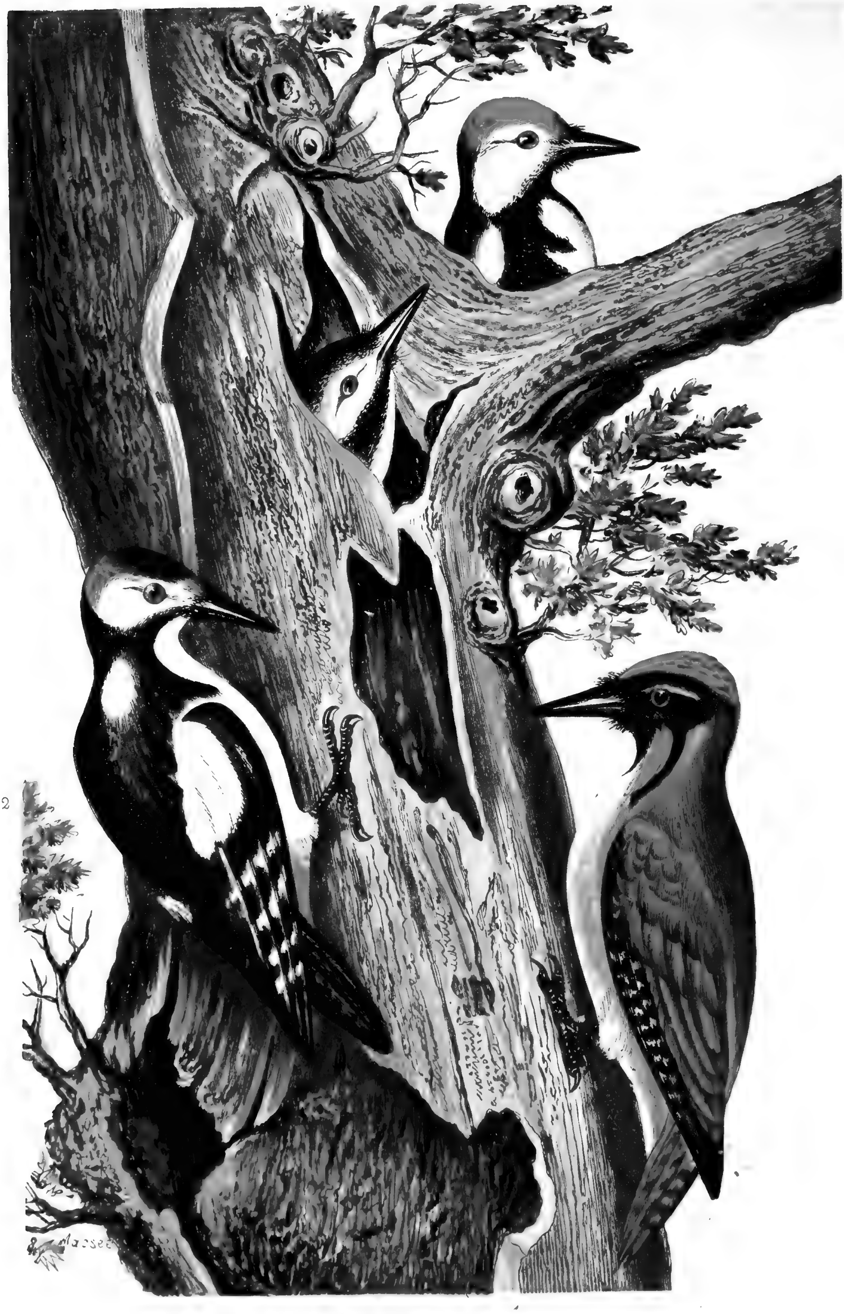
Cassella's Embossing Self-Recording Anemometer.—One of these instruments has recently been erected at Kew Observatory. It has the hemispherical cups of Dr. Robinson, but the registering apparatus has been devised by Mr. Cassella and Mr. Beckley. A narrow slip of paper, sufficient to last a month or six weeks, is wrapped round a roller; this strip is unwound by a clock movement, which marks each hour by embossing an arrow upon it, and figures, expressing the wind's velocity in miles, are embossed on one edge. We are informed that the performance of this ingenious instrument works is highly satisfactory.

Slow Incubating Silk-Moth Eggs.—M. Guérin Méneville describes in *Comptes Rendus* a race of silkworms whose moths only produce one generation in two years, and the incubation lasts eighteen months. This variety was raised in South America from eggs sent from Europe, and their peculiar behaviour in this hemisphere was first noticed in Italy.

Prehistoric Art.—M. Peccadeau de L'Isle exhibited recently to the French Academy specimens of wrought flints, barbed arrows, etc., from Bruniquel, and among them a figure which he said might have been intended as a fantastic creation by its author, or possibly meant for an elephant, sculptured on a piece of reindeer horn.

The November Meteors.—Professor Adams has communicated to the Royal Astronomical Society the result of his investigation as to the true orbit of these bodies. Upon calculating the perturbations caused by the action of Venus, Jupiter, and the earth upon the node of the nearly circular orbit, having a period of about 11 days less than that of the earth, in which the meteors have been supposed to travel, he finds that the result is not sufficient to produce one-half of the observed motion. He was therefore driven to the alternative of adopting an elliptical orbit, with a period of $33\frac{1}{4}$ years, extending beyond Uranus, and he then found that perturbations caused by Jupiter, Saturn, and Uranus, the only planets now likely to affect the meteors, produced exactly the required amount of motion in the node. He proceeded to ascertain all the elements of the orbit, which were found to be almost identical with those of Tempel's comet, thus corroborating the speculation as to the identity of these bodies very remarkably.

The Vaginicola Valvata.—Mr. J. G. Tatem, of Reading, informs us that the valved vaginicola described by Mr. Slack in our last number is common in that neighbourhood.



BRITISH WOODPECKERS.

THE INTELLECTUAL OBSERVER.

(With a Coloured Plate.)

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[illegible] to which the *pectoral*, or wing [illegible]. In the present genus, whose food [illegible] in forests, and whose flight is [illegible] short distances from one tree to another [illegible]

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THE INTELLECTUAL OBSERVER.

JUNE, 1867.

BRITISH WOODPECKERS.

BY G. EDWARD MASSEE.

(*With a Coloured Plate.*)

The group *Scansores,* or climbers, is represented in the British Isles by three families, which include seventeen species, out of which eight only can be considered indigenous; the remaining nine being merely visitors of rare occurrence. The genus *Picus* contains but three true British species, though six others have been added to the list of British birds, on the grounds of one or two of each having been captured or seen here.

The places most frequented by woodpeckers are forest districts, where, amongst the interstices of the bark, and the decayed portions of the trees, they find a constant supply of insects and their larvæ, which constitute the principal part of their food, and for the capture of which their whole frame is admirably adapted. The hæmal spines, which in most of the vertebrata are distinct, are coalesced in birds into a single bone, called the *sternum,* or breastbone, which is subject to various modifications in different families. Birds whose food is principally taken on the wing, or who have to fly long distances to procure it, have in general a broad breastbone, furnished with a prominent keel or ridge descending from the median line of its under surface, to which the *pectoral,* or wing-muscles, are attached. In the present genus, whose food is principally procured in forests, and whose flight is rarely extended beyond the distance from one tree to another, the crest, or central ridge of the breastbone, is remarkably small. Their powerful toes, two of which are directed forwards and two backwards, are furnished with large, deeply curved claws, by which they are enabled, with the assistance of their stiff and pointed tail feathers, to move along the trunks and branches of trees in all directions. The beak is long, straight, and tapering from base to apex. The tongue is retractile, and the tip is armed with barb-like bristles, by which their insect prey is impaled.

The Green Woodpecker (*Picus viridis*, Linn.) is best known and most widely distributed amongst British species, but, in common with the rest of the genus, it possesses the facility of quickly moving its position on the trunk of a tree so as to interpose an efficient screen between itself and any observer, its green plumage harmonizing with the surrounding objects, and its shy and retiring habits, lead to the belief that this bird is more rare than it really is. During the spring months the silence of the forest is often broken by the loud monotonous cry of this bird, which, once heard, will never be forgotten; it is most frequently uttered before impending rain, and thus serves as a barometer to the woodman, as does the pimpernel to the shepherd. Its flight is heavy and undulated, but on the rough surface of a tree its movements more resemble those of a snake than of a bird, its brilliant crimson crown flashing like flame when lighted by the sun's rays, as it glides in a spiral manner round the stem, tapping the bark to dislodge the numerous insects which shelter amongst its irregularities. It may also be frequently seen on the ground in the vicinity of ant-hills, feeding on the ants and their eggs, to which it is very partial. The nest is placed in a decayed tree, the cavity being excavated or enlarged to suit its wants; the eggs are pure white, from four to six in number, and are deposited on a layer of decayed wood without any other lining. This bird is often dislodged from its breeding place by the common starling, which, though inferior in size, invariably succeeds in taking possession of the contested cavity, in which it builds its nest.

The Great Spotted Woodpecker (*Picus major*, Linn.) is less frequent than the preceding species, which, however, it much resembles in its habits, with the exception that it is more frequently seen apart from woods, in places where old posts or stumps abound, under the decayed bark of which live innumerable insects, on which it feeds, both in the larval and *imago*, or perfect state.

Mr. Gould, in his *Birds of Europe*, speaking of this species, says, "Nor are they free from plundering the fruit-trees of the garden, and, in fact, commit great havoc among cherries, plums, and wall-fruit in general." Having succeeded in keeping a bird of this species in confinement for nearly two years, my observations lead me to form an opinion differing from that stated by the above-mentioned author. The young woodpecker was taken from the nest before the quill feathers were developed, and was kept in a small box, where it was fed with various kinds of insects and spiders. When it was two months old I placed it in a small canary cage. The bottom and the sides, to the height of two inches, were composed of beechwood, which was rather decayed, and

perforated in all directions by the larvæ of a small beetle (*Ptinus pectinicornis*). The remainder of the cage was composed of wire, through which it tried to escape, but finding it impracticable, commenced beating in quick time at various parts of the woodwork with its beak. About ten minutes after leaving the room in which the cage was, I was called by the servant, who said that the bird had escaped and flown up the chimney. It was with difficulty that I captured it, and on taking down the cage I found to my surprise that in so short a time it had bored a hole sufficiently large in the bottom of the cage to allow of its escape. Whether it had pecked away the wood in search of the beetles, or with the intention of escaping, I cannot say. After fixing a stouter piece of wood over the hole in the cage, I returned it, but it repeatedly succeeded in effecting its escape, when it would perch on the head of any one present, and invariably commence an attack on the face and eyes. I afterwards placed it in a cage, composed wholly of wire, and provided it with wood, which, if suitable, was perforated in all directions. It never became tame, but regularly attacked my hand when I offered it food. The cat, too, kept at a considerable distance from the cage, after having once received a severe peck on the nose from the point of its powerful beak, while looking for a space large enough for the introduction of her foot. Its food consisted of insects, and during the winter months, when these could not be procured, I found a good substitute in uncooked meat, but fruit, nuts, or seeds of any description were invariably rejected. It never attempted to sit on the perches that were provided for it, but scrambled round the sides of the cage by clinging to the wires after the manner of parrots, with the exception that it never made use of its bill to assist its movements.

It is generally believed that these birds convey to a distance from the place, the chippings which are made during the excavation of the nest, which would, if allowed to remain at the root of the tree, lead to the detection of the nest. A careful observation of the habits of them, both in confinement and in their native woods, has led me to the conclusion that this is not their usual practice. When a piece of wood was given to my caged bird, it at once proceeded to test its soundness, by dealing in quick succession a series of hard blows with the point of its beak, on various parts of the surface. If it proved to be perfectly sound, it was left untouched; but if at all decayed, the bird would drill first a small hole with the point of its beak, which it afterwards enlarged by pecking off minute pieces from the circumference until it was as large as desired. While engaged in this task it would stop at intervals, and climb round the sides of its cage apparently for the sake of viewing

its work from all points; at the same time uttering a peculiar low chuckle, as if satisfied with its performance. Of the different kinds of wood given to it, the favourite piece was either beech or fir, and if these two were placed in the cage together, it invariably commenced upon the beech. I never found amongst the *debris* a chip larger than a grain of wheat, but the greater portion was like fine sawdust. The holes bored were always round. Now it is well known that these birds always choose for their breeding-place trees which are decayed or hollow in the centre. Inside the bark, where the wood is partly decayed, the woodpecker scoops out a hollow sufficiently large to contain its eggs, generally selecting for this purpose a position about a foot below the entrance, and the *debris* made during the construction of the nest falls into the hollow of the tree. Last year the upper part of an old oak was blown down in Castle Howard park. In the remaining portion of the trunk was a woodpecker's nest, found by me before the accident occurred to the tree, but which I could not reach from the outside. On climbing up the shattered trunk, I found the centre hollow, and round the circumference were five woodpeckers' nests, one of which contained four eggs, and at the bottom of the tree was a large accumulation of particles of decayed wood, the result of the labours of these birds, while making their nests, or searching for insects.

The Great Spotted Woodpecker is inferior in size to the Green Woodpecker; the general colour of its plumage is black and white, the crown and the feathers near the undertail coverts are bright crimson.

Lesser Spotted Woodpecker (*Picus minor*, Linn.). This is the rarest, as well as the smallest of the British woodpeckers; its total length not exceeding five and a half inches. In the colour of its plumage this bird somewhat resembles the last-mentioned species, but may be distinguished from it by its smaller size, and by the greater amount of white on the wings. It frequents woods, orchards, and isolated trees in search of food, which, like that of its congeners, consists of insects. It is exceedingly shy, and when surprised, seldom seeks safety in flight, but trusts to its activity in keeping a branch between itself and the object of its alarm. Its note is loud for so small a bird, and is like the noise made by the turning of a crank, whence its local name of crank-bird. The eggs are white, like those of the two preceding species, and are found in the same situations.

The three following birds are natives of North America, and are separately described in *Wilson's American Ornithology*, Jameson's edition:—

Downy Woodpecker (*Picus pubescens*, Linn.).

Golden-winged Woodpecker (*Picus auratus,* Linn.).

Hairy Woodpecker (*Picus villosus,* Linn.). Surely Montagu was mistaken in supposing that this species was common in the North of England.

Great Black Woodpecker (*Picus martius,* Linn.). The nest of this bird, containing four eggs, was found by my friend Mr. Wise in the New Forest, Hants.

Three-toed Woodpecker (*Picus tridactylus,* Linn.). This and the preceding species are not uncommon in certain districts of the European continent.

Middle Spotted Woodpecker (*Picus medius,* Linn.). This is now proved beyond doubt to be the young of the Great Spotted Woodpecker (*Picus major,* Linn.).

DESCRIPTION OF THE PLATE.

Fig. 1. Green Woodpecker (*Picus viridis*); Fig. 2. Great Spotted Woodpecker (*Picus major*); Figs. 3 and 4. Male and female of the Lesser Spotted Woodpecker (*Picus minor*).

ON THE APPLICABILITY OF THE ELECTRIC LIGHT TO LIGHTHOUSES.

BY PROFESSOR M'GAULEY.

NOTHING can be more important to any maritime country, but especially to one having so extended a commerce as ours, than the subject of lighthouses. Their importance is evident from the fact that the sudden and unexpected extinction of one of the lights on our coasts might cause the loss of many lives, and the destruction of many hundreds of thousands of pounds of property; and accordingly we consider it good policy to spend very large sums annually in the construction and maintenance of lighthouses.

Warning the mariner of the dangers which he incurs on his approach to land is not a mere modern practice. Beacon fires are of high antiquity; they are alluded to by Homer and several ancient writers. The celebrated Pharos of Alexandria was erected about three hundred years before Christ; but whether its light was that of a fire, or was produced by some more elaborate contrivance, cannot now be ascertained. It is said to have been visible at the distance of forty miles, but this is more than improbable. The famous Colossus of Rhodes, one of the wonders of ancient times, an immense statue of bronze, was erected about the same period; but, after a very few years, it was thrown down by an earth-

quake, and it remained where it fell until the close of the seventh century of the Christian era, when its materials were sold to a merchant of Edessa for a sum equivalent to thirty-six thousand pounds of our money. The Tour de Cordouan, at the mouth of the Garonne, is one of the most ancient of the modern lighthouses; a fire of wood was first used in it, then one of coal, and afterwards lamps and reflectors. To it was first practically applied the dioptric apparatus, which has brought lighthouse illumination to such a state of perfection. Until a comparatively recent period, grates with burning coals continued to be employed to warn the mariner. One of these is still to be seen at Lucerne in Switzerland, in the very place where it was long exhibited for the purpose of guiding the boatmen on the lake at night; and to it is most probably due the name of the interesting old town, where it still attracts the attention of the traveller.

The ingenuity of modern times was not satisfied with the contrivances with which the rude nations of antiquity were content. The clumsy grate, with a wood or charcoal fire, was superseded by the more steady and brilliant light of lamps: and means were devised for directing the light thus obtained, in all its intensity, to those points at which it was required. Reflectors were first used for the purpose; and as, from their nature, they are easily acted on and deteriorated by the atmosphere, it was often sought to supersede them by lenses, but long in vain. The imperfect figure of the lenses which would be sufficiently large for the purpose, the impossibility of obtaining considerable masses of glass free from serious imperfections, the large quantity of light absorbed by such great thicknesses even of the most transparent material, all conspired to render the numerous experiments made on the subject unsuccessful; until the persevering ingenuity of scientific men eliminated every difficulty, and at length produced the magnificent dioptric apparatus now in use.

Buffon endeavoured to diminish the absorption of light which occurs with large lenses, by cutting away their superfluous portions, and causing them to consist of a number of concentric zones or rings; but the impossibility of properly polishing the complicated surface, caused at one side of the lens by the different zones, also the liability to irregularity of curve, and the certainty of flaws in the large masses of glass required, rendered the expedient, however ingenious, inapplicable in practice.

But all these obstacles to complete success were overcome by the sagacity of Sir David Brewster, who, through a long and valuable life, has done so much for optical science. He built up the lens of separate rings, and the rings even of sepa-

rate pieces, in 1811; and thus what was carried into practice eleven years after by Fresnel, and has been considered his invention, is merely the application of the polyzonal lens of Sir David Brewster. These improvements, and the substitution of totally reflecting prisms by Alan Stephenson, for reflectors previously employed with the new dioptric apparatus, seem to leave nothing more to be desired in this department of lighthouse construction. But, like other valuable discoveries and inventions, that of Sir David Brewster, notwithstanding all its advantages, came but slowly into use. France was the first to avail itself of so important a contrivance. In 1822 Fresnel built up a lens, and, as suggested long before by Sir David, used it in conjunction with mirrors in the lighthouse of the Tour de Cordouan. In 1834, in consequence of the recommendation of the House of Commons, a revolving light, on the same principle, was placed on Inchkeith, and a fixed light on the Isle of May.

The attention of scientific men, as far as lighthouses are concerned, is now almost confined to the discovery of the best mode of producing the light. That in ordinary use leaves little to be desired, when the weather is tolerably clear: since a first-class oil light, at the height at which it is usually elevated, is visible from the masthead when the vessel comes above the horizon of the lighthouse—the nature of our climate would not allow a greater elevation to be given to the lights. It is, therefore, in hazy weather that a more intense light becomes desirable. Science furnishes more than one such light. Among these is the Drummond Light, which possesses both advantages and disadvantages when applied to lighthouses—the preponderance of the one over the other not being, however, very decided; and the electric light, which may in time supersede all others on the mainland, especially if some of the inconveniences by which it is accompanied are removed, or even lessened. The necessity for a steam-engine, when it is employed, renders it inapplicable on rock stations, such as the Eddystone Lighthouse, and the Bell Rock.

In the employment of the electric light, two very important matters are to be considered: the production of the electricity, and its transformation into light. The most obvious mode of effecting the former would be the use of the galvanic battery: and, accordingly, numerous experiments have been made with that object. Among others, a most important series, in the central workshops of the Administration of Lighthouses in France from 1848 to 1857. So far as the mere production of an intense light was concerned, the success of these experiments was complete. But the expense of the battery was very great, and the irregularity of the results obtained was very

serious. It was therefore concluded that galvanic electricity is not suited to the purposes of lighthouse illumination.

Within the same period, a new mode of obtaining the electric light, founded on the production of currents by magnetic induction, was tried with great success. In 1853, Professor Holmes made experiments on the light obtained by means of electro-magnetic machines, which had been used by a Parisian company for the decomposition of water, with the object of its constituents being used for combustion, but, commercially, without success. The apparatus was imperfect; nevertheless, the results were very encouraging; and they became still more so when a better apparatus was used. Holmes's apparatus was tried at the South Foreland lighthouse, in 1859: and its performance was favourably reported on by Mr. Faraday. But, after some time, its use was discontinued there, because it was considered that the light produced by it might, on account of its great intensity, be visible when other lights on the same coast would no longer be perceptible, through foggy weather: and that vessels might thus be fatally led astray.

With a magneto-electric machine, the electricity is obtained by causing soft iron, round which insulated wire has been coiled, to revolve in front of one or more permanent magnets. The inductive action of the permanent magnets causes temporary magnetism in the electro-magnets, constituted by the soft iron on which the insulated wire has been coiled. For, as the circulation of electric currents around soft iron causes it to be magnetized, so the magnetization of soft iron causes the circulation of currents round it, and therefore in the insulated wire coiled upon it. When it approaches the permanent magnet, a current in one direction is generated; and when it recedes from it, and returns to its natural state, a current in the opposite direction. A very simple contrivance, called a *commutator*, causes both currents to proceed in the same direction, and therefore to produce a combined effect: and these currents may be called into existence so rapidly, as to render the light emitted by them, so far as our senses are concerned, continuous and uniform.

It is obvious that the production of light, in this way, is merely an example of the correllation of the physical forces, and of a change of the imponderables, successively, one into the other. Luminous calorific and actinic rays, emitted by the sun—it cannot ever be conjectured how long ago—were absorbed by the vegetable which gave rise to the coal: these, in the furnace of the steam boiler, are liberated in the form of heat: this heat is changed by the steam-engine into motion: this motion is changed into electricity by the magnet: and this

electricity is restored to its original form of light, in its passage between the charcoal points of the electric lamp. It is equally easy to trace the changes which take place, when the motion of the magneto-electric apparatus is produced by muscular force, instead of by the steam-engine.

It is not necessary to use permanent magnets, in the development of electricity by means of induction. Recent experiments by Mr. Siemens show that the permanent magnets may be replaced, in such experiments, by electro-magnets. And he even believes that such a substitution would be advantageous, under the supposition that the permanent magnets become impaired in power, by use in this way. But both the French and English official experiments on the applicability of the electric light to lighthouses, have shown the contrary to be the fact.

Wilde's magneto-electric machine is intermediate between the ordinary magneto-electric machine and that suggested by Siemens's experiments. It is constructed on a principle long since brought forward by M. Seguin the elder. In Wilde's apparatus, electricity is produced by permanent magnets, in an armature which is an electro-magnet of a peculiar form, and is made to revolve rapidly. The electric current, thus generated, in the armature, is used to excite a system of electro-magnets; and these develope a more intense current in a second electro-magnetic armature, which also revolves rapidly. This second current is used to excite a second system of electro-magnets; and these develope a still more intense and extremely powerful current in a third electro-magnetic armature; which, like the others, revolves rapidly. Each armature makes about three thousand revolutions in a minute; and it is the wear and tear which must arise from heavy masses moving with so high a velocity that constitutes the great objection to this very ingenious and most powerful machine.

Mr. Holmes's apparatus was transferred from the South Foreland to Dungeness, in 1862. It was fixed over an oil lamp apparatus, lest any accident should render it incapable of being used. The Elder Brethren of the Trinity House refuse to sanction the use of the electric light, unless when, in case of its failure from any cause, it can be instantly replaced by the ordinary oil apparatus. Moreover, with the electric light, a duplicate of every portion of the apparatus is required, lest any of it should get out of order.

The apparatus at Dungeness consists of one hundred and twenty permanent magnets of about fifty pounds each, ranged on the periphery of two large wheels. One hundred and sixty soft iron cores, surrounded by coils of insulated wire, are made to revolve past the magnets one hundred times in a minute, by steam power. The streams of electricity, thus produced, are

collected together by means of a commutator, the alternate positive and negative currents being brought into one direction. The combined current is conveyed, by a thick wire, from the engine-house to the illuminating apparatus, where it forms a continuous and brilliant spark between two charcoal points, which are maintained at a proper distance apart by means of a balance arrangement, and an electro-magnet, round which the wire coils. The charcoal points are consumed in about three hours and a half; after which period they are changed, without extinguishing the light, as it is the kindling of the second pair which puts out the first. In more recently constructed machines, a smaller number of magnets and soft iron cores are employed.

At the close of 1859, experiments were commenced by the French Lighthouse Engineers, with an electro-magnetic machine obtained from the Alliance Company. This apparatus consisted of fifty-six magnets, distributed in seven equidistant planes, on the angles of a right octagonal prism. The electro-magnetic armatures, which were fixed on discs turning round the axis of the prism, and were made to revolve by a steam-engine of two-horse power, passed between the groups of magnets. The alternate currents were brought into the same direction, and united into one, without a commutator. Sixteen changes of direction corresponded to every revolution of the disc; and a maximum of intensity was obtained, when the machine made about four hundred revolutions in a minute; in which case, the current was reversed six thousand four hundred times in a minute.

The electric lamp, which was used with these experiments, is so contrived as that the charcoal points approach each other, according as they are consumed, without, in any case, coming into contact. When they are at the proper distance apart, two forces, one derived from a spring, the other from an electro-magnet, the coil of which is traversed by the current, balance each other, and the points remain at rest; but when, on account of increased distance between these points, the power of the current is diminished, the spring comes into action, and causes the points to approach, until their motion is stopped by the restoration of energy to the electro-magnet. This apparatus may be adjusted to the power of any given current; and, notwithstanding its delicacy, it has been found to work with great precision. Much, however, depends on the nature of the charcoal points; those made from the deposit on the interior of gas retorts, and obtained in commerce, do not give complete satisfaction, and it is not easy to obtain others of a better kind, and quite free from objection. The want of homogeneity in the charcoal causes constant variations in the light, however

uniform the electric current may be. The same injurious effect is produced by very slight alterations of the distance between the points, and by changes of the luminous arch from one side of the points to another, an occurrence which sometimes takes place. A slight displacement of the focus would throw the rays too high, or depress them too low. No displacement, however, greater than five millimetres, has been observed, which would raise or depress the bundle of rays only through two degrees; and the light sent from the lighthouse to the horizon would still be in excess of that from the very best oil apparatus. A report was made to the French government, regarding these experiments, in 1863.

Two magneto-electric machines have been placed in the double lighthouse on the Cap de la Hève; and other nations are following the example of England and France, in attempting the introduction of the electric light into lighthouses.

The reports made to both the English and French governments, on the application of the electric light to lighthouses, in a great degree coincide, and they enable us to form a very fair idea of the advantages and disadvantages which attend its use. Both agree in the assertion that there has not yet been time to form a final judgment regarding the matter.

Nothing can exceed the brilliancy of the electric light; no other light can compete with it. Faraday estimates its power at eight times that of a first-class ordinary light; and he found that it was comparable with that of the sun, when both were seen together. When seen with the ordinary oil light, the extinction of the latter produced no perceptible diminution of effect, nor its being re-lighted, any augmentation. The peculiar bluish tint of the electric light is rather an advantage, since it causes it to be more easily distinguished from other lights. But it may be made of any colour, and intermittent, according to any law. Its capability of being instantaneously extinguished, and re-lighted, at pleasure, would enable it to be used on parts of the coast where, on account of the difficulty hitherto experienced, of producing lights easily distinguishable, it has not been found advisable to erect lighthouses. The same property also fits it well for signalling; and it would be very easy to make any lighthouse in which it is used, tell its own number, by means of certain periodical extinctions. It is entirely free from the enormous shadow cast by the oil apparatus, its descending rays being unabsorbed.

The intensity of the electric light is not, however, so great an advantage as might, at first, be supposed. The oil light now in use can, as we have said, be seen quite as far, in fine weather; and in fogs, sufficiently dense to hide the sun, both become invisible. But, when it ceases to be visible, the engine

required for obtaining it may be turned to good account in bell-ringing, and the production of other sounds much louder, and therefore audible to a much greater distance, than those which are possible with the means at present employed.

It is only in intermediate states of the atmosphere that the electric light has advantages over the ordinary light. At other times, its intensity is considered by the French engineers, even as a disadvantage, since it causes the eye to be dazzled, and therefore renders it incapable of seeing distinctly. Comparisons have been made between it and a first-class oil light, in hazy states of the atmosphere; and it has been found that its advantage rapidly diminishes as the state of fog is approached. But, with the electric light, the greatest power of the rays may be directed a little below the horizon, so as to give more intensity to the plunging rays; which is impossible, with the ordinary light, without reducing the distance at which it will be visible. And the necessity for having a duplicate steam-engine makes it easy, without much additional expense, to double the power of the apparatus, which increases the penetrative capability of the light. Thus, when an electric light, of a given power, in a given state of the atmosphere, will be visible for the distance of not quite sixteen kilometres, a light of double the power will be visible, in the same state of the atmosphere, for more than seventeen kilometres. The light of a first-class oil apparatus, in the same circumstances, would be visible only for the distance of about thirteen kilometres.

The optical apparatus required by the electric light is less expensive than that which must be used with a light of the ordinary kind. The optical apparatus must, in every case, bear a relation to the light in its focus; and the oil light is far larger than the electric. With the ordinary optical apparatus, the electric light would not have sufficient divergence; and the rays would be thrown into the form of a ring, either whole or broken. When an oil light requires an optical apparatus 1·84 met. in diameter, one 0·30 met. in diameter will be large enough for the electric light. If, therefore, a new lighthouse is to be erected, there will be, with the electric light, a great saving in the item of optical apparatus; but, if the electric light is to be substituted for the ordinary oil light, the augmentation of expense, attendant on its use, will be considerable.

The cost of the electric light, both in its application and maintenance, is very serious; though not sufficiently so to justify its rejection, should it be found, in other respects, advantageous. The Elder Brethren of the Trinity House state that the cost of the apparatus which it requires, and even the maintenance of the light, far exceed those of an ordinary dioptric light of the first order. The apparatus at Dungeness

cost £6,626 6s. 3d.; and the annual expense of maintaining the light is £724 16s. 4d. But they admit that, as yet, no definite opinion can be formed on this point. In the report made to the French government, it is stated that, when a first-class lighthouse is to be erected, the cost will be considerably less, if the electric light is used; that, if the electric light is merely substituted for an oil light, there will still be a saving, though not to such an extent; and that the cost of maintaining the electric light is far less than that of maintaining an ordinary oil light. There can, however, be no doubt that the necessity for keeping duplicates of the apparatus, including even the steam-engine and boiler, and an oil apparatus, all ready to work at a moment's notice, as required by the Trinity House, must seriously augment the expense, both of first construction and maintenance. The complexity of the apparatus increases the liability to derangement, and the cost of repairs. It can be worked only by men of a superior class, and, therefore, who demand higher pay than the ordinary lighthouse employés. The engineer, especially, who keeps the apparatus in order, must be such a person as cannot always be had; and in the case of misconduct, sickness, or death, it might be difficult to replace him, particularly at remote stations. But there is nothing to prevent one engineer from having charge of several neighbouring lighthouses.

The last consideration to which we shall direct the attention of our readers, is the most important of all—the reliability of the electric light. If it cannot be entirely depended on, it can never come into general use for lighthouses. It has, indeed, attained a certainty and steadiness that has given entire satisfaction to the Elder Brethren; nevertheless, they insist on precautions in using it, which add very much to the expense. In justification of their strictness, in this regard, it must be admitted that, both in this country and on the continent, the electric light has occasionally gone out, and, in some instances, for not inconsiderable periods of time. In most cases, but not all, these interruptions have arisen from neglect on the part of those in charge of the apparatus; but this is precisely a source of failure which it will always be most difficult effectually to guard against. The management must necessarily be carried on in two places—the engine-room and light-room. In the former there is great danger of disarrangement, or neglect; in the latter, there can be no absolute security against some unfortunate accident. The electric lamp now in use, is, it is true, very certain in its operation; but it is of extremely delicate construction, and cannot, without risk of derangement, be committed to the charge of inexperienced and unskilful persons.

It must be borne in mind, in weighing the advantages and disadvantages of the electric light, that no new contrivance has ever been rendered perfect, at once. For any other purpose but that of a lighthouse, the electric light is sufficiently reliable; and it is only because the slightest interruption of the light, in a lighthouse, would be fraught with the most imminent peril to life and property, that extraordinary precautions are deemed necessary by the Trinity House—precautions which are rarely justified by an actual failure of the electric light, but which, from its possible occurrence, are indispensable.

Should improvement advance so far, that the electric light will become entirely reliable, which, however, seems very improbable, if not impossible, duplicates of at least the more solid portions of the apparatus might be dispensed with, and an oil apparatus, in conjunction with the electric, would not be required. The cost of the electric light would then, most probably, be less than that of the ordinary oil light; while the advantages it would secure would make it greatly preferable to any other light that could be applied to lighthouses.

THE LOW BAROMETER OF THE ANTARCTIC TEMPERATE ZONE.

BY RICHARD A. PROCTOR, B.A., F.R.A.S.

The great difficulty presented by the science of meteorology lies in the intricate combination of causes producing atmospheric variations, and the impossibility of determining, by experiment, the relative efficiency even of the most important agents of change. As Sir W. Herschel well observed, we are in the position of a man who hears at intervals a few fragments of a long history narrated in a prosy, unmethodical manner. "A host of circumstances omitted or forgotten, and the want of connection between the parts, prevent the hearer from obtaining possession of the entire history. Were he allowed to interrupt the narrator, and ask him to explain the apparent contradictions, or to clear up doubts on obscure points, he might hope to arrive at a general view. The questions that we would address to nature, are the very experiments of which we are deprived in the science of meteorology."*

It is, therefore, but seldom in the study of this science that we meet with phenomena to which we can assign a definite

* Kaemtz's *Meteorology.*

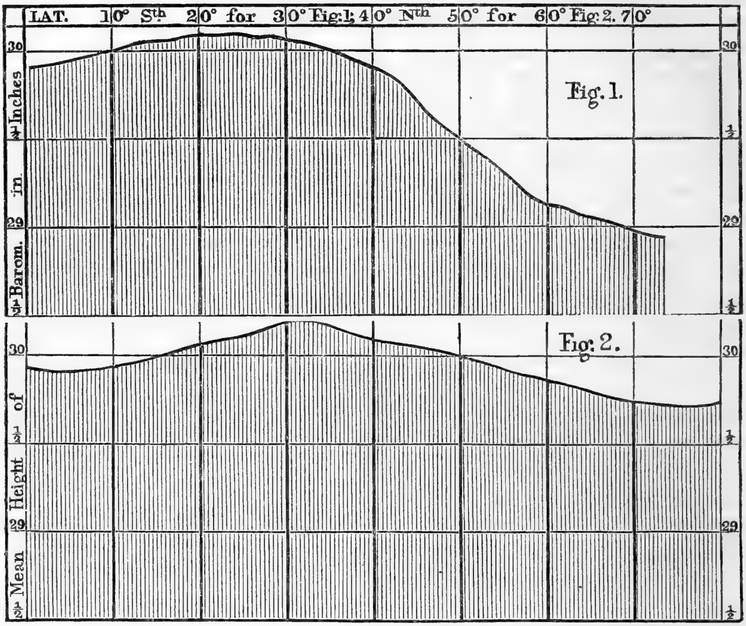
cause, or which we can explain on simple principles. Even those marked phenomena which appear most easily referable to simple agencies, present difficulties on a close investigation, which compel us at once to recognize the efficiency of more causes than one. For instance, the phenomenon of the trade-winds, as explained by Halley, appears at first sight easily intelligible; but when we look on this phenomenon as a part merely—as indeed it is—of the marvellously complex circulation of the earth's atmosphere—when we come to inquire why these winds blow so many days in one latitude, and so many in another, or why they do not blow continually in any latitude—when we consider the character of these winds as respects moisture and temperature, the variation of the velocity with which they blow, and of the quantity of air they transfer from latitude to latitude—we encounter difficulties which require for their elucidation the comparison of thousands of observations, or which baffle all attempts at elucidation.

There is, however, one atmospheric phenomenon—that which I have selected for the subject of this paper—which presents a grand simplicity, rendering the attempt at a simple solution somewhat more hopeful than is usually the case with meteorological phenomena. The discovery of this phenomenon formed one of the most interesting results of Captain Sir J. C. Ross's celebrated expedition to the Antarctic Ocean. He found, as the result of observations conducted during three years, that the mean barometric pressure varied in the following manner at the latitudes and places specified:—

South latitude.		Height of the barometer.	Place.
0°	0′	29·974 in.	At sea.
13	0	30·016	—
22	17	30·085	—
34	48	30·023	Cape of Good Hope & Sydney.
42	53	29·950	Tasmania.
45	0	29·664	At sea.
49	8	29·469	Kerguelen & Auckland Isles.
51	33	29·497	Falkland Isles.
54	26	29·347	At sea.
55	52	29·360	Cape Horn.
60	0	29·114	At sea.
66	0	29·078	—
74	0	28·928	—

We see here a gradual increase of barometric pressure from the equator to about 30° south latitude, and from this point at first a gradual diminution—so that in about 40° south latitude we find the same pressure as at the equator, and thence a more rapid diminution. The rate of change is illus-

trated graphically in Fig. 1, which represents the height of the barometer above 28½ inches for different southern latitudes. In the northern hemisphere there is a similar increase of pressure as we leave the equator, a maximum is there also attained in about latitude 30°; but from this point towards the



poles there is a marked difference in the rate of diminution of pressure in the two hemispheres. The following table by Schow is sufficient to indicate this:—

North latitude.	Barometric pressure.
0°	29·853 in.
10	30·002
20	30·004
30	30·069
40	30·006
45	30·011
50	29·943
55	29·960
60	29·835
65	29·623
70	29·722
75	29·863

There are minor irregularities in this table, due, doubtless, to local peculiarities, the arrangement of land and water being

so much more complicated in the northern than in the southern hemisphere. Neglecting these (as in Fig. 2, which represents for the northern hemisphere the relations corresponding to those exhibited for the southern hemisphere in Fig. 1), we see that there is a much greater resemblance between the rise and fall of barometric pressure as we proceed northwards than as we proceed southwards. In fact, the curve is almost exactly symmetrical on either side of 30° north latitude to the equator on one side, and to latitude 60° on the other. From 60° the pressure continues to diminish for awhile, but appears to attain a minimum in about latitude 73°, and thence to increase. In the southern hemisphere, if there is any corresponding minimum, it must lie in a latitude nearer the south pole than any yet attained.

The most marked feature in the comparison of the two hemispheres is the difference of pressure over the southern and northern zones, between latitudes 45° and 75°. This is a peculiarity so remarkable, that for a long time many meteorologists considered that the observations of Captain Ross were insufficient to warrant our concluding that so important a difference really exists between the two hemispheres. But not only has Captain Maury—from a comparison of 7000 observations—confirmed the results obtained by Ross, but, in meteorological tables published by the Board of Trade, the same conclusions are drawn from 115,000 observations, taken during a period of no less than 13,000 days. In fact, it is now shown that the difference is yet greater than it had been supposed to be from the observations of Captain Ross. From a comparison of observations made in the Antarctic Seas with those of Captain Sir Leopold McClintock, it appears that the average difference of barometric height in the northern and southern zones, between latitudes 40° and 60°, is about one inch. Figs. 1 and 2 exhibit a relation midway between these later results and those tabulated above.

Assuming an average difference of only three-quarters of an inch in the northern and southern zones, between latitudes 40° and 60°, let us consider what is the difference of pressure on these two zones of the earth's surface. The area of either zone is 21,974,260·5 square miles, and the pressure on a square mile due to a barometric height of three-quarters of an inch is about 670,000 tons, therefore the pressure on the northern zone, between the latitudes named, exceeds the pressure on the southern zone by no less than 14,500,000,000,000 of tons. Including all latitudes within which there has been ascertained to be a difference of barometric pressure in the two hemispheres, we shall probably be within the mark if we say, that the atmospherical pressure on the northern hemisphere is

20,000,000,000,000 tons greater than the atmospherical pressure on the southern hemisphere.

Such a peculiarity as this may almost deserve to be spoken of in the terms applied by Sir J. Herschel to the distribution of land and water upon our earth, it is "*massive* enough to call for mention as an *astronomical feature.*" I propose to examine two theories which have been suggested in explanation of this feature of the earth's envelope. These theories are founded on *local* peculiarities, and the feature considered appears as a *dynamical* one—that is, as a peculiarity resulting from states of motion in the aërial envelope. I shall endeavour to establish a theory founded on a consideration of the earth's mass *as a whole*, and presenting the atmospheric feature in question as a *statical* one.

The first theory I have to notice is one founded on the configuration of land and water upon the northern and southern hemispheres of the earth's globe. In the northern hemisphere, and more especially in that part of the northern hemisphere in which barometrical observations have been most persistently and systematically conducted, there is much more land than in the southern hemisphere. Now barometrical observations are referred to the sea-level, and observations made in Europe and America may be considered as referred to the level of the northern parts of the Atlantic Ocean. It is argued that the North Atlantic, compared with southern oceans, is little more than "a large lake, having elevated banks east and west." "Practically, the air there is a portion of the solid globe, so that the unconfined air will rest upon and rise above the former, as if it were solid and a portion of the earth; so that the altitude of the air over the North Atlantic will be increased some hundreds of feet, and the barometer at the sea-level will be pressed upon, not only by the free air clear of the earth's banks, but also by the air confined in the basin, much as if the air were at the bottom of a mine."*

Presented in the above form, the theory that the higher northern barometer is due to the contour of the northern hemisphere scarcely deserves serious comment. To speak of the confined air of the North Atlantic Ocean is surely unreasonable. An ocean 2000 miles across, swept by more frequent storms than are experienced in any other part of the globe, cannot be very aptly compared to "the bottom of a mine." An inelastic fluid flowing steadily over a rugged surface shows no trace, or but the slightest trace, of the nature of that surface by any variations of its own level. But it is still less conceivable

* From a letter addressed to the editor of the *Athenæum*, by Dr. H. Muirhead.

that an elastic fluid should be influenced in the manner suggested. In fact, if this happened we should no longer be enabled to determine the heights of mountains by barometric observations; for according to the theory the air should extend to a greater height above mountains than above plains; and as regards comparison between a barometer at the foot of a mountain and one at the summit, we might argue that the barometer in the valley, compared with a barometer at the same level in a plane district, "is pressed upon, not only by the air clear of the mountain tops, but also by the air confined within the valley," so that the altitude over the valley is greater by some hundreds of feet than the altitude over a plain at the same level as the valley; and thus, before we could determine the height of the mountain above the level of the plain, we should have to determine the exact effects due to the confinement of the air in the valley. We know that, on the contrary, the average barometric pressure in the most confined valley does not differ appreciably from the average pressure over the most widely extended plain at the same level.

We may, however, reasonably inquire whether the presence of continents in the northern hemisphere might not operate in another manner. If we place any mass within a vessel containing fluid, it is clear that we increase the fluid pressure over every point of the vessel's bottom, because this pressure depends wholly on the depth of the bottom below the level of the fluid, and the level rises when any solid substance is placed within the vessel. Now if we suppose a globe covered all over by water to be surrounded by a perfectly uniform atmospheric envelope, the mean pressure of this envelope at the water-level would certainly be increased if continents were supposed to be raised in any manner above the surface of the water; and if the atmosphere over one half of such a globe were supposed to be prevented in any way from mixing freely with the atmosphere over the other half, then it is clear that the mean pressure at the water-level would be greatest on that half-globe over which the most extensive and highest continents had been raised. On the assumption, then, of some such arrangement over our own earth—an arrangement, that is, which should prevent the northern air from mixing with the southern—one might see in the northern continents a true cause of increased barometric pressure at the sea-level of the northern hemisphere.

We have, however, not only no evidence that such an arrangement exists, but very strong evidence of an atmospheric circulation which carries air from hemisphere to hemisphere, and mixes in the most intimate manner the whole mass of

gases which form the earth's atmospheric envelope. The whole question of the circulation of the air is investigated in Maury's interesting work on the *Physical Geography of the Sea,* and he appears to establish in the most convincing manner, the interchange of air between the northern and southern hemispheres.

And even if we could assume that the atmospheric covering of any portion of the earth's surface was in any way prevented from passing freely to other regions, yet the cause assigned would be inadequate to account for the difference of barometric pressure actually existing between the two hemispheres. All the land above the sea-level in the northern hemisphere, if uniformly distributed over the surface of that hemisphere would be raised to a height of less than 200 feet above the present sea-level, and the actual difference of level corresponding to the observed difference of barometric pressure is more than four times as great.

Passing over this theory as neither consistent with the known laws regulating the motions of elastic fluids, nor sufficient even if the consideration of those laws were neglected, we come to the theory suggested by Captain Maury—a theory deserving of much more attentive consideration. I shall quote his own words, as the fairest method of presenting his theory; after stating the observed difference of a barometric pressure in the two hemispheres, and mentioning the expulsion of air from the northern hemisphere as the cause of this difference, he writes :—"To explain the great and grand phenomena of nature, by illustrations drawn from the puny contrivances of human device, is often a feeble resort, but nevertheless we may, in order to explain this expulsion of air from the watery south, where all is sea, be pardoned for the homely reference. We all know, that, as the steam or vapour begins to form in the tea-kettle, it expels air thence, and itself occupies the space which the air occupied. If still more air be applied, as to the boiler of a steam-engine, the air will be entirely expelled, and we have nothing but steam above the water in the boiler. Now at the south over this great waste of circumfluent waters, we do not have as much heat for evaporation as in the boiler or the tea-kettle; but, as far as it goes, it forms vapour, which has *proportionately* precisely the same tendency that the vapour in the tea-kettle has to drive off the air above, and occupy the space it held. Nor is this all. This austral vapour, rising up, is cooled and condensed. Thus a vast amount of heat is liberated in the upper regions, which goes to heat the air there, expand it, and thus by altering the level, causes it to flow off."

The theory thus divides itself into two parts: we have first

the expulsive effects due to the vapour raised from southern oceans; and, secondly, the expansive effects due to the liberation of heat as the vapour is condensed. Now I would, in the first place, submit that we cannot assign to the second cause the effects here considered. The amount of heat liberated as the vapours rising from southern oceans are condensed is undoubtedly great, but it cannot be more than the equivalent of the amount of heat rendered latent as the vapours are formed, and therefore the expansive effects due to the liberation of heat cannot be greater than the contrary effects due to the prior imprisonment of heat. It is quite true, and has been accepted as the undoubted explanation of many climatic effects, that if vapour be raised in one place and condensed over another, then the temperature of the air over the latter place is raised. But when we have to consider a phenomenon extending over a zone twenty or thirty degrees in width, we cannot argue in this manner. Nay, it is *necessary* to the force of Maury's second cause that the condensation of vapour should take place over the very zone in which the vaporisation is proceeding. To assign similar effects to both processes, is to require that the winding up and the loosening of the spring should take place in the same direction.

Whatever effects, then, are due to the constant evaporation going on in the southern hemisphere must not be derived from changes of temperature. So far as these are effective at all, they must depend on the excess of evaporation over condensation (since the excess cannot possibly lie the other way), and therefore represent diminution of heat or increase of pressure, the contrary effect to that we have to account for. We have, therefore, only to consider the first cause mentioned by Maury; that is the expulsive effects due to the formation of aqueous vapour.

At first sight, this process of expulsion appears simple enough, and seems further to coincide with many well-known phenomena. The theory supposes that over a wide zone of the southern hemisphere aqueous vapour is continually rising; that as it rises it displaces in part the heavier air over these regions; and that equilibrium being thus disturbed, the excess of air flows off continually towards the equator. Now we know that the prevailing surface-winds over that zone of the southern hemisphere in which the barometer exhibits the peculiarity we are considering, blow from the equator; that is, they tend to sweep the lower strata of the atmosphere towards the south pole. They therefore tend to increase the quantity of humid air in high southern latitudes. We know also that the prevailing upper currents over the southern zone we are considering, blow towards the equator. They tend, therefore,

to carry the drier portion of the air towards the equator. All this seems in accordance with Maury's theory, and, indeed, if the prevailing upper and lower currents flowed in directions contrary to those indicated, the theory would fall at once.

Again, although we find no evidence in barometric pressure over the south tropical zone of that increase which Maury's theory would lead us to expect (since the surplus air is carried first to this zone), yet it might be argued that the surplus is so distributed, as to appear in another way. It is evident that if the atmospheric envelope normally appertaining to the southern hemisphere were, through the effects of the causes assigned by Maury, increased in extent, this increase might show itself, not in an increase of pressure over the south tropical zone—that is, not in an increase of *height* there—but in the extension of the surplus atmosphere into the northern hemisphere. This would be shown by the extension of the southern trade-winds to or beyond the equator, so that the (so-called) equatorial zone of calms should lie north of the equator. As this is really the position occupied by the belt of calms, Maury's theory appears to gain additional force by the coincidence.

Another argument may be drawn from the analogy of the low barometer in moist weather. In fact, it is well known that Deluc explained this phenomenon in a manner precisely accordant with the views expressed by Maury.

Despite the apparent force of these arguments, and others that might be adduced, it will not be difficult, I think, to show that neither is Maury's theory consistent with known physical laws, nor (passing over this objection) is the theory *sufficient* to account for the grand phenomenon under consideration.

It is quite true that a volume of aqueous vapour weighs less than an equal volume of air; it is equally true that a volume of moist air weighs less than an equal volume of dry air *at the same tension.* But water, quietly evaporating in the open air, does not displace the air, but penetrates into its interstices, according to the well-established law regulating the mixture of vapours. The aqueous vapour which thus intimately mixes itself with the air produces no effect whatever, either by its weight, or by its elasticity, on the movements of the atmosphere. The experiments of Gay-Lussac, Dalton, and others, have long since proved that the actual effects of the quiet evaporation of water are those here described. It is on this account that Deluc's hypothesis in explanation of the fall of the barometer when the air is moist is now no longer accepted. It has been shown that the observed fall is not due to the moistness of the air, but to increase of temperature. Hot winds bring (in Europe) moist air, and thus moist air and a low barometer are found to be coexistent phenomena. But they are not in the

relation of cause and effect. In fact, in New Holland, where hot winds bring dry air, we find the barometer low when the air is dry.

It follows from what has just been said of the manner in which aqueous vapour associates itself with air, that atmospheric pressure is increased instead of diminished by the process of quiet evaporation, since the weight of the vapour is added to that of the air. Therefore, all things being equal, we should expect to find the barometer higher in the southern or watery hemisphere than in the northern.

It might seem unnecessary to consider Maury's theory further, but as some doubts may still remain whether some process of the kind conceived by him may not take place,* I proceed to consider the *efficiency* of such a process to account for the great phenomenon we are dealing with.

It must be remembered, in the first place, that the theory requires that there should be a greater volume of mixed air and vapour over the southern temperate zone, than there is in the corresponding northern zone, otherwise there would not be that continual overflow towards the equator which is required by the theory. So far as it goes, this increment of volume implies an increment of weight. The increase of volume is more than compensated (in theory) by diminution of specific gravity, but it must be held in mind that the increase of volume has to be accounted for by the theory *as well as* the difference in barometric pressure.

Again, the theory requires that the upper regions of air should be dry, for it is the upper air that is carried towards the equator; and if this air were moist, we should no longer have the different proportions of moist and dry air which are required by the theory. We *must* have an aggregation of moist air in high southern latitudes, and of dry air towards the equator.

Again, we must call to mind that one-half of the northern hemisphere is covered by water, and a part of the southern hemisphere is not so covered, so that the effects suggested by Maury are (1) not peculiar to the southern hemisphere, nor (2) do they prevail over the whole of that hemisphere.

Lastly, we must remember that the process conceived by Maury must be wholly or principally a diurnal process, and so

* In fact, Sir. J. Herschel, in his work on Meteorology, assigns as a cause of the low barometric pressure near the equator, compared with that near the tropics, a process similar to that conceived by Maury, only depending on the excess of heat near the equator. I cannot but agree with those meteorologists who consider that the notion of any appreciable *uplifting* of the air by the rising vapour of water is a mistaken one. But whether it be so or not, it is evident that Herschel's view would require a regular increase of pressure from the equator to the antarctic pole, and therefore is opposed to Maury's explanation.

can only take place (on an average) over one half of the southern zone at any one time.

All these considerations tend to diminish very importantly the efficiency of the cause assigned by Maury. Let us, however, consider what is the maximum value that efficiency could have if all these circumstances were neglected. We shall see that even in this case, which assigns an efficiency at least three or four times as great as would be consistent with actual facts, we shall still find the cause assigned by Maury inadequate to the production of the phenomenon under consideration.

The greatest weight of aqueous vapour which is ever present in a given volume of air is equivalent to about one-sixtieth part of the weight of the air. Now, if we suppose the barometer at thirty inches, and the whole column of air above the barometer to be impregnated with air in the above-named proportion—a view very favourable to the theory, since the cold of the upper regions of air largely diminishes the proportionate weight of aqueous vapour—it is clear that one-sixtieth part—or half an inch—of the barometer's height is due to the presence of aqueous vapour. Now, at mean tensions the specific gravity of aqueous vapour is about three-fifths of the specific gravity of air, so that the proportion of one-sixtieth part of weight corresponds to a proportion of one-thirty-sixth part of volume; in other words, our column of air owes one-thirty-sixth part of its height to the presence of aqueous vapour. If we suppose this thirty-sixth part to flow off—not from the upper regions only, but in such a manner that one complete thirty-sixth part of the volume of the column should pass off—then, instead of standing at a height of thirty inches, the barometer would stand at a height of $29\frac{1}{6}$ inches, less by only one-third of an inch than the height of $29\frac{1}{2}$ inches due to the dry air alone. Now, we cannot, in accordance with Maury's theory, legitimately add the five-sixths of an inch of barometric pressure to the height of the barometer under a neighbouring column. For we have no evidence to show that the air assumed to be expelled from the southern temperate zone is heaped over the southern tropical zone; on the contrary, we have a barometer in the latter zone not quite so high even as the barometer in the corresponding northern zone. Therefore if air is expelled in the manner supposed by Maury, it must be distributed over a very much greater portion of the globe's surface than it had been expelled from. Hence, returning to our imaginary column of air, but a small fraction of the five-sixths of an inch due to overflow must be added to the barometer under a neighbouring air-column. The latter barometer originally at $29\frac{1}{2}$ may be fairly assumed to rise at most to about $29\frac{5}{6}$ inches. We

have, then, a difference of $29\frac{5}{6}$—$29\frac{1}{6}$ inches, or two-thirds of an inch; so that despite all the opposing considerations we have neglected, we still have a difference less by one-third than that for which we have to account; and, indeed, so far as the comparison between the northern and southern temperate zones is concerned (and this is the true question at issue), we are only entitled to consider the third part of an inch lost by overflow, as the true measure of the efficiency of this cause.

So far as I am aware, the theory I am about to present in explanation of the phenomenon of a low antarctic barometer, is original. It is sufficiently simple;—perhaps, if we remember how very seldom physical phenomena admit of a simple explanation, one may say that the theory labours under the disadvantage of simplicity.

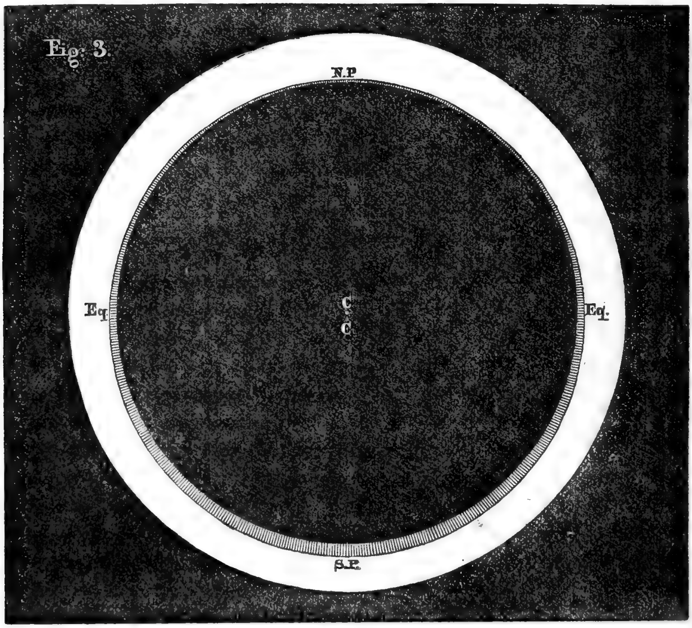
It is obvious that the centre of gravity of the solid portion of the earth's globe lies somewhat to the south of the centre of figure. This arrangement has long been accepted as the explanation of two remarkable geographical features—the prevalence of water over the southern hemisphere, and the configuration of nearly all the peninsulas over the whole globe. Whether or not those parts within the antarctic regions which have not yet been explored, are occupied by land (chiefly) is a question which has little more bearing on our views respecting this point, than has the counter question—whether the unexplored north-polar regions are or are not occupied by a north-polar ocean.* Supposing these arrangements to exist, it is evident that they form mere local peculiarities. The general tendency of water towards the southern hemisphere is very obvious, and, so far as I am aware, no other explanation of the peculiarity has ever been offered than that founded on

* Captain Maury holds the affirmative on both points. I have already had occasion to discuss in these pages his theory of a *tidal* north-polar ocean, and I think the theory cannot be maintained. But the theory of a polar ocean communicating with the Atlantic and Pacific is a sufficiently probable one. The theory of an antarctic continent is hardly in the same position, since antarctic explorations have given us but faint indications, here and there, of the habitudes of the south-polar regions. But I may note, in passing, a very singular argument used by Captain Maury in favour of the existence of such a continent. He states it as a physical law that land is scarcely ever antipodal to land; "therefore," he says, "since the north-polar regions are probably occupied by a vast ocean, the south-polar regions are probably occupied by a vast continent." He seems to forget that it by no means follows that because land is seldom antipodal to land, water should seldom be antipodal to water. Since the extent of water is nearly three times that of land, it is absolutely necessary that nearly two-thirds of the water should be antipodal to water. The supposed peculiarity that nearly all the land is antipodal to water (one-twenty-seventh only being antipodal to land), is in reality no peculiarity at all. It would have been far more singular if any large proportion of the land (which occupies little more than one-fourth of the globe) had been antipodal to land.

a slight displacement southwards of the earth's centre of gravity. If, then, C is the centre of the black circle in Fig. 3, representing the solid part of the earth, the centre of gravity of this part lies (in the Fig.) slightly below C—between C and C′, let us suppose.

Now we see that, owing to this slight displacement, the watery envelope of the earth tends southward. If the earth were a perfectly uniform spheroid, it is clear that there would be a tendency to some such arrangement as is represented (on a greatly exaggerated scale) in Fig. 3, in which the shaded part represents the sea—that is, a shell of water, thicker towards the south, would surround the solid earth. For our present purpose it is sufficient to consider this supposed arrangement, as minor inequalities of the earth's surface-contour

Fig. 3.



have clearly nothing whatever to do with the phenomenon we are considering.

Let C′ be the centre of the spheroid which bounds the earth's fluid envelope. Then it is very clear that if this envelope were of the same specific gravity as the solid portion of the earth, the centre of gravity of the entire mass would lie very near C′, but slightly south of that point, on account of the slight southerly displacement of the centre of gravity of the solid portion. But when we consider that the specific

gravity of the fluid envelope is less than one-fifth of that of the solid globe, it is perfectly clear that the centre of gravity of the entire mass will not be so far south as C′. For, of the entire mass, the northern half is the heavier, and therefore the centre of gravity must lie north of the centre of the entire mass—that is, north of C′. In fact, it must lie much nearer to C than to C′.

Thus, the centre of gravity of the solid globe, and that of the entire mass, solid and fluid, both lie between C and C′. Now it is evident that the central point, about which the earth's atmospheric envelope tends to form itself as a spherical or spheroidal shell, is the centre of gravity of the entire solid and fluid terrestrial globe—that is, is a point north of C′. Therefore, precisely as the effect of the fluid envelope collecting itself centrally about a point *south* of C is to cause the mean depth of water to be greatest in the *southern* hemisphere, so the fact that the atmospheric envelope collects itself centrally about a point *north* of C′ should result in giving a greater mean depth of air (*referred to the sea-level*) over the *northern* hemisphere. This arrangement is represented in Fig. 3, in which the unshaded part is supposed to represent the atmosphere.

I have endeavoured to make the above explanation of my theory in explanation of the low antarctic barometer as complete and exact as possible; but there is another way of presenting the theory which, though less complete, may appear clearer to some minds:—

Variation of mean barometric pressure, as we proceed from one place to another, may be due either to a variation of circumstances of heat, moisture, and other like relations, or to a difference of level. Maury's explanation assigns to the low antarctic barometer a cause or causes falling under the former category. My theory amounts to the supposition that the low barometer is due to an absolute difference of level. I say that the sea-level, to which we refer barometric pressure, is *not* a just level of reference when atmospheric pressure over the whole globe is the subject of inquiry, because the southern seas stand out to a greater distance than the northern seas from the true centre of gravity of the earth's solid and fluid mass.

Assuming my theory to be correct, we have a means—rough, it may be, but not uninstructive—of determining the displacement of the centre of gravity of the earth's solid mass from the centre of figure. For, accepting one inch as the difference of barometric height at the two poles, it is easily calculated that this difference amounts to a difference of level of about 850 feet. In other words, the surface of the water at

S. P. lies farther than the surface of the water at N. P. from the centre of gravity of the entire fluid and solid globe by about 850 feet. Hence this centre of gravity must lie about 425 feet north of C′ (which is the centre of the bounding surface of the water). Now, it is evident that both the centre of gravity of the entire fluid and solid mass, and that of the solid mass, must lie much nearer to C than to C′. Hence both these centres of gravity lie considerably within 400 feet of C, and C′ lies considerably within 825 feet of C. Thus the centres of figure and the centres of gravity of the earth's solid mass, and of the entire fluid and solid mass, are collected within a space less than one-eighth of a mile in length—a distance almost evanescent in comparison with the dimensions of the earth's globe.

A RAMBLE IN WEST SHROPSHIRE.

BY REV. J. D. LA TOUCHE.

We left our tourist on the top of the Stiperstone range of hills, beholding a scene of mingled wildness and fertility, combined with considerable antiquarian and geological interest.

Pleasant, indeed, is that remote region in the long summer days, where, knee-deep among the heather and whinberries, you pick your steps, sometimes not without trouble, by the path stretching along the ridge from one to the other of the picturesque masses of rock, over thickly-strewn fragments of quartz, glittering like frosted silver in the rays of the sun; and pleasant it is to recur, even in thought, to a scene so removed from the "windy ways of man," and where you can muse in perfect quietness on the miracles of nature around.

But we must not leave our traveller here; there is much work before him if he is to dive into the mysteries of the thickly-bedded strata of the Llandeilo rocks, and when he has satisfied himself of the state of things in the primæval world, when trilobites and other creatures which have long passed away, inhabited the dreary, silent wastes, he will find ample occupation in tracing the manners and customs of his own species, in the vestiges they have left behind them—the races who have, from time to time, lived in these now sequestered valleys, and, attracted by their mineral treasures, pursued their earnest search for wealth into the very heart of the earth itself.

Our tourist now surveys, for the most part, that important subdivision of the Lower Silurian rocks, called the Llandeilo.

The Stiperstone range, upon which he stands, is pronounced by Sir R. Murchison to be the equivalent of the Lingula flags of North Wales; and as he would find no perceptible difference in the inclination of these two strata (the Lingula and the Llandeilo) in this neighbourhood, both dipping at an equally high angle towards the west, he might at first be led to suppose that they succeeded each other in point of time, as they do in position. There is, however, reason to believe, as Professor Ramsay has pointed out, that a stratum of great thickness, called the Tremadoc slates, was deposited between the era of the Stiperstone formation and that of the overlying Llandeilo flags. It would be impossible here to repeat all the reasons which the professor has set forth in his most interesting and instructive paper on "Geological Breaks," as leading him to this conclusion. But it will be of interest to state the circumstances under which, according to him, such breaks occur, since the geologist has frequent opportunities of witnessing instances of them on a minor scale; indeed, every section of a gravel and sand-pit furnishes illustrations of them.

The omission of such a stratum as this, found elsewhere, must, he says, arise from one of three causes: either, 1, the lower rocks were, at the time of its deposition, raised above water in the particular spots where it is omitted, and only submerged when it had been completed; 2, the deficient stratum may, indeed, have been deposited over the entire area, but was subsequently in parts washed away or denuded; or, 3, it may have been deposited in some parts, and not in others. Instances illustrative of the two latter of these causes are seen in every river deposit. The stream, sometimes diverted from its ordinary channel by the impetus it receives in a high flood, deposits a quantity of debris from high grounds in places where there had been but little previously, while in others it carries off the sand and stones which had been deposited. Of course, illustrations of upheaval can only be studied on a large scale; but it is possible, by attentively observing the layers of gravel so often exposed to view in a river bank or quarry, to arrive at a solution of some very interesting geological phenomena relating to this subject; and this study I would specially commend to persons who live far removed from the more striking manifestations of geological disturbances, in uninteresting (as they are called) and level countries, where, from the nature of the ground, the slow and sluggish streams wend their way, or on the sea-shore, where over banks of sand and mud, each ebb and flow of the tide leaves its own deposit, or carves out and modifies those previously made.

Here, on a stupendous scale, it is believed that some such

process must at one time have gone forward. Between the deposition of the Lingula flags of the Stiperstones, and the Llandeilo, which overlie them so regularly that there is nothing in this neighbourhood to suggest that they are not one stratum, there is believed to have been an enormous interval of time, since their fossils are widely different. Well, in North Wales are found strata which, judged by their fossil contents, are the equivalents of those of the Stiperstone rocks, and again strata equivalent to the Llandeilo; but between them a huge slice, called the Tremadoc slates, with fossils of a character intermediate between those of the strata above and below it. It is, therefore, to be presumed that this slice is the representative of a vast cycle of change in the organic life of these regions, of which no vestige whatever is left in the neighbourhood we are now examining—a missing link in the development of organic life is found, and a problem solved which would otherwise be inexplicable. But, still further, we are taught the important lesson of caution in our deductions from observed phenomena. It might have been inferred, from the sudden change in the organic life displayed by these successive strata, that its progress was capriciously interrupted and its character suddenly changed at a certain epoch; but this discovery of the Tremadoc slates with their intermediate fossils, is an additional reason to believe in that gradual, progressive development of species which so many other lines of research would seem to affirm; and it, moreover, shows that when, in studying other parts of the great geological volume, we might occasionally be led to suppose exceptions to this great law, such a conclusion may arise from some other missing links, some other pages, or even entire chapters, having been torn rudely from the venerable record.

At last we are prepared to descend through one of the numerous gorges, dingles, or cwms (as they are sometimes locally called) which penetrate these strata, running into them from the west, and exposing the Llandeilo rock, dipping at a very high angle towards the same quarter. Their thickness has thus been estimated at not less than 3000 feet. For the most part they are barren of fossils, except at the very top or the very bottom of the beds; to use the familiar illustration of my friend Mr. Salter, like a thick piece of bread well buttered on both sides. It will be understood that the bottom strata constitute the high hills which we have just left, and the higher are found in the valleys upon which we are now entering. As I stated before, the only spots in which I am aware of fossils being found are the little hollows on the high grounds formed by the sheep for shelter. There are other places mentioned in Sir R. Murchison's *Siluria,* such as Lord's Hill, near the Chapul;

but I have not been so fortunate as to hit on the exact spot. Indeed, I recommend those who explore this region to be moderate in their hopes of making a collection of fossils. Some spots of extraordinary richness are occasionally found, from which it is possible to carry off a profusion of capital specimens in an excellent state of preservation; but you may examine many a dreary cubic yard, or, I might even say, cubic mile of rock, without being repaid by a single fossil. A couple of summers ago, I was applied to by a gentleman, who professed to be an ardent collector, for some information as to the best localities in which to look for fossils; and having given him as accurate directions as I possibly could, he started on a three days' tour through the district. But when he returned, the whole of his spoils were contained in his waistcoat-pocket. This may appear discouraging, but it must not be supposed that all are equally unfortunate; on the contrary, some of my most satisfactory fossil-hunting days have been spent among the Llandeilo flags. I shall not attempt to enter upon the large subject of the fossils to be obtained here, since, to do it justice, it would be necessary to copy largely from Sir R. Murchison's important work; armed with which, no one can be at a loss to ascertain and classify his spoils. Suffice it to say, that they consist chiefly of tribolites of various kinds, orthoceras, and lingulas, interspersed with a few bivalve shells.

The most interesting feature in the lithological character of the rocks of this neighbourhood, is the occurrence among them of several layers of what Sir R. Murchison describes as "felspathic aglomerates and ash beds, or volcanic grits, as well as slaty porphyries, with crystals of felspar. Some of them alternate in ridges with the schist containing tribolites, others constitute courses of a few inches thick only, and occasionally include fragments of *Ogygia Buchii*. Organic remains are also found in beds composed almost exclusively of igneous materials, thus showing that volcanic action was rife at the sea bottom in which these lower Silurian strata were accumulated." And to account for these facts, that is, for the alternate layers of shale and felspathic rock, he supposes that these gritty beds were formed of the debris of submarine volcanoes. In recent times such have occurred, of which Graham Island, in the Mediterranean, is an instance. A cone of ashes and other volcanic products is formed, and is pushed upwards to a considerable height above the surface of the sea; subsequently it is attacked by the waves, and the scoriæ of which it was composed is spread out over the sea bottom. This in time is covered by the deposit of mud which, under ordinary conditions, is ever going on. A fresh eruption, and another cone would supply a second layer of felspathic ash, and so on

till, as in this neighbourhood, some six or eight would be formed.

With all respect for the illustrious propounder, if not the author of this theory, a tourist may be excused if certain questions suggest themselves to his mind before he can admit it, as a completely satisfactory solution of the problem; and when he considers that the opinion of geologists, as to what are, and what are not really volcanic rocks, has of late years been considerably modified, he may desire to know something more of these "felspathic ashes," their composition, history, and origin, before deciding the question. It is certainly very striking how frequently in rocks of this age, these alternate layers of shale and grit occur. At the Briedden they are conspicuous, and Sir R. Murchison describes them as occurring in "The rocky tracts extending from Llandegley and Llandrindod by the hills of Gelli Gilwern, and Carneddan to Builth," at Festiniog Tom-y-bwlch, and Cader Idris, etc. The occurrence, however, of somewhat similar alternations in other strata, though not perhaps so distinct and striking as they are here, may lead some to conclude that a more general law may be found to account for them, and that possibly they may only be another instance of that segregative force which we have had occasion to remark upon already—a force dividing the elements of these primeval rocks into their constituent parts, the clay separating itself into distinct beds, and the gritty and the more crystallizable materials also uniting into a stratum. Possibly this very tendency to crystallization may be the prime mover in the whole process, just as, to use a familiar illustration, it will cause the sugary portions of a pot of jam which has been kept long enough, to segregate into a layer distinct from the less crystallizable portion.

The Llandeilo rocks are succeeded, according to the opinions of the best geologists, by the Caradoc, or Bala series. These are largely exhibited on the east of the Longmynd, *i.e.*, in the Caradoc, and the country to the north and south of that striking hill, but are not found on the west, where the Llandeilo are immediately succeeded by much more recent rocks, such as the Wenlock shale, the intervening strata being omitted.

That there is a real distinction between the Caradoc or Bala beds, and the Llandeilo beneath them, there seems to be reason to doubt. Professor Ramsay says, "The community of the ordinary species of fossils in the Llandeilo and Caradoc or Bala beds induces me to treat them as one group;" and Sir R. Murchison himself speaks very cautiously about their separation, saying, "It is not pretended that a line can anywhere be precisely drawn upon a map between these strata." And,

accordingly, he has in the map which accompanies his work, shaded off the colour which indicates the one into that of the other, in that part of Montgomeryshire, where, as he believes, a distinction may be observed between the two. No doubt the fossils found in the two strata, as represented on each side of the Longmynd, are widely different, at least specifically, yet they may not be more so than might be expected in the upper and lower members of a stratum of such enormous thickness as this appears to be. If this be so, we may consider the rocks on this western side of the Stiperstone and Longmynd range, rising up as they do at a high angle towards the east, to be the continuation of a vast arch, of which the other extremity is the Caradoc and neighbouring hills, the great centre of upheaval being along the axis of the Longmynd.

This sketch of the geology of this district would be incomplete without drawing attention to a much more recent formation, which is very well displayed in some portions of it. This is the Llandovery, elsewhere divided into two members, the upper and the lower, but of these the former alone has left any traces here; it is in all these cases, however, seen to rest on very much older rocks, unconformably. Near Norbury it reposes directly on the Llandeilo, and it has left a small patch here and there (as will be seen by reference to the geological maps) in the great valley of Llandeilo, which we have been exploring; but at the southern extremity of the Longmynd, and along a considerable portion of its eastern flank, it rests on the much more ancient Cambrian, bearing a strong resemblance to a sea-beach.

These facts suggest, that between the times of the deposition of these strata a great change had taken place in the level and position of the underlying rocks, and it has been suggested as probable that the Longmynd, at the time of the formation of the Llandovery, presented the appearance of an island. It is here interesting again to notice the coincidence of a great change in organic life, with these evidences of a very long interval between the two formations. Out of the prodigious number of fossils found both in the Caradoc and the Llandovery rocks, only twelve species are known to be common to both. When we contemplate these strata, resting as they do upon the highly inclined rocks of the Longmynd, the mind is irresistibly carried back to reflect on the history of this region. There was at first a period during which the 26,000 feet of the Cambrian was forming; then another, during which the Lingula flags of the Stiperstone range were deposited. Then there was a vast interval, perhaps of subsidence, represented by the Tremadoc slates. Then again fresh deposits commenced over the entire area, and 3000 feet of Llandeilo

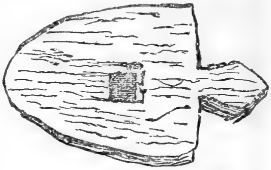
flags were formed; after which, possibly, that great upheaval took place, during which a mighty fault along the Stretton Valley, estimated by Professor Ramsay at 2000 feet, was effected, and the strata of the Longmynd reared up into an almost perpendicular position, as may be seen around Church Stretton. Then came a long period of denudation, such as is at this moment going on over the whole surface of the country, by which the frost, the rain, and other atmospheric agencies are incessantly wearing down the whole surface, and carrying it off in rivers to the sea. Then, and not till then, were the Llandovery conglomerates deposited on the denuded edges of the previous rocks, since which there has been a further upheaval, an interval of time measured by the more recent formations, nearly thirteen miles thick altogether, which are met with in succession as we cross England in an easterly direction, and the inconceivably slow process by which the whole surface of the country has been moulded into its present aspect, under atmospheric influences.

Let us now turn our attention, though it must be more briefly than the subject deserves, to the objects of antiquity which abound in this district. They are, for the most part, closely connected with the working of the lead mines, which in very early ages attracted to them the industry of the Romans.

Ingot of Lead from Linley.

An interesting testimony to this fact is extant in a large ingot of lead which is in the possession of Rev. F. More, of Linley Hall, and of which a sketch is here presented. This ingot is stamped with the words I. M. P. HADRIANI AUG., executed in well cut letters; its weight is just 190 lbs., and it is the exact duplicate, I am informed, of another that was discovered in a different place, but in the same neighbourhood. On each side it is possible to trace the grain of oak wood, stamped, as it were, upon the lead, from which it is inferred that the mould in which it was cast was made of that timber; but a more curious and interesting fact is the occurrence likewise on each side of the impression of a fern leaf, so distinct, that the species, *Blechnum boreale,* can be determined. How did this come here? Could that frail organism have permanence enough to impress its form on the molten mass as it was poured into the mould? Why one fern leaf on each side? Was it accidental or intentional, a kind of trade mark or private stamp? Together with this relic of Roman industry, Mr. More, whose diligence in collecting and preserving these curious remains

has been very great, has in his collection some ancient wooden spades of oak, and of a curious pattern. The handle was evidently inserted in the hole which is represented in the accompanying drawing, and tied to the short handle with which each was furnished; thus affording a tolerably effective implement when iron was yet an expensive metal. But lastly, Mr. More possessest wo precious relics, which, as being composed of far more perishable material, are justly prized by him very much; they are two candles, apparently formed originally of tallow, but this has undergone the change into adipocere, which frequently takes place with fatty substances when exposed for a very long time to certain atmospheric action, and by which it has become extremely hard and almost chalky in its nature. The form,



Spade found in Roman mine near Shelve.

Roman (?) Candle found in Roman mine near Shelve.

however, of these candles is quite preserved; they resemble our ordinary "dips," and a fracture in the side of one of them reveals an inner core, which would arise from their being formed by two successive dippings in the melted tallow. The wicks of both of them are made of hemp, cotton being then, of course, unknown. Both these and the spades were found in one of the workings of the Roman mine; and it is therefore possible that they date as far back as the times of that people. But although, as Mr. Wright informs me, there is good evidence that the Romans used candles, a candlestick having actually been found at Wroxeter, it might not be easy to determine that these interesting relics are of so ancient a date as this, since, indeed, the mines from which they came seem to have been in constant work down to the present day, when "Limited Liability" projects, to enrich the fortunate shareholders, teem on every hand.

In his antiquities of Shropshire, Mr. Eyton says of Shelve, that "it was famous in the twelfth and thirteenth century for its lead mines. In 1182, the king seems to have had the lead mines in his own hands. The sheriff had conveyed the king's lead from Shrewsbury to Gloucester, at the cost of £3 8*s.* 9*d.*, as certified by William Fitz Simeon and Warin Fitz Alric. He had further purchased 110 cart loads of lead for the king, at the cost of £38 10*s.* This lead is expressed to be 'ad operationes ecclesie de Ambresb.' This explains the whole

matter. The great Wiltshire nunnery of Aymesbury had been dissolved by Henry II. in 1177, on account of the immorality of its members. The house was newly inaugurated as an abbey on May 31 in the same year, and colonized with a purer sisterhood from the Abbey of Fontevrault. The King, the Archbishop of Canterbury, and the Bishops of Exeter and Norwich attended the ceremony. Henry II. left nothing undone which could contribute to the dignity of the new foundation, and Aymesbury became the select retreat for females of the aristocracy. The lead mines of Shelve doubtless furnished the roof of the conventual Church."

But it is time to draw our ramble to a close, although we have by no means exhausted the objects of interest in this neighbourhood, though we might with pleasure examine the curious circles of stones near the foot of Corndon, and the tumuli of departed heroes which are said to abound on its summit, and the relics of more recent times in the hypocaust and remains of a Roman villa which still exist close to Linley Hall; and though by permission of the hospitable owner of that handsome place we could with profit linger over the ingenious and most instructive model which he has had made of the surrounding country, enough will have been said to show that a few days spent in the neighbourhood of the Stiperstones will not be thrown away; and now that an excellent hotel (I am not a shareholder) is established at Church Stretton, a good centre of operations has been created, and a country for the most part inaccessible, if not inhospitable, has been opened up to the lovers of science and of scenery. It may be hoped that its many objects of interest may be investigated as they deserve to be.

PICTURE-NOTES.—THE ROYAL ACADEMY.

The picture exhibition of the Royal Academy for the present year is, on the whole, an interesting one; and it would be easy to make a pretty long list of artists whose works evince considerable technical skill, and possess a fair amount of beauty in colour or form. If, however, we pass by those pictures which are simply pleasing, and take no account of many preposterous and crotchety failures, we have left a good many productions of artists whose labours command large prices, whose reputation stands high, and who aim, more or less successfully, at an elevated mark. Amongst these there are some who deserve great praise, while others—and they comprehend several of the R.A.'s—have fallen far below their own fame. The deplorable want of English artists is mental cultivation and imaginative power. They rarely conceive their subjects in a fine spirit, and, as a rule, their pictures lack sentiment, dramatic vigour, and poetic treatment. The present exhibition shows these defects very glaringly, and chief amongst the defaulters are painters whose reputation has long been made.

Sir Edwin Landseer sins most grievously against all rational principles of art in his big picture of the "Queen at Osborne in 1866." The sentiment intended to be conveyed by this piece is that of the grief and loneliness of our sovereign in her widowhood. The queen is represented in a black riding-habit, on a dark pony, held by a gilly who looks as if he had been borrowed from the undertaker. A little dog, standing on his hind legs, seems, from the colour of his coat, as if he had put on mourning during a temporary sojourn up the kitchen chimney; the grass has the aspect of faded green baize, and a grey, drizzling cloud gives a damp, half-mouldy aspect to the scene. In his better moods Sir E. Landseer could not have painted such a picture. It is not a grief as conceived by the artist, but as it might be arranged for exhibition by the undertaker. The gentlemen who "perform" funerals could also "perform" this sort of woe, and hundreds of their profession would thankfully supply the article by contract, according to weight or measure, as might be agreed. A true artist—Sir Edwin himself in his artistic moods—would have perceived the morbid affectation and unnaturalness of the method of treatment which he has adopted, and which is founded on the conceit, that an air of general discomfort pervaded the universe because an illustrious personage died. There is however no symptom of that power which might command the sympathies of external

nature, fill the world with gloom, and "let darkness be the burier of the dead." A grand method of treatment, embodying this sort of conception, would, no doubt, have been out of place; it could only be appropriate to such a scene as that of Calvary, or some other stupendous tragedy, in which one of earth's noblest martyrs died.

As a rule, nature and life are full of contrasts; the grass does not wither, nor the puppy turn soot-colour, because death exacts his tribute from the domestic circle. Deep private sorrow casts no shadow on the skies or the fields; the flowers spring up in their glittering brightness, the lark soars and sings in the blue heaven, when the kindest hearts are withered, and the best beloved persons seek their resting-place in the grave. Landseer has failed, egregiously failed, in his delineation; the picture is weak, washy, maudlin, and unnatural. It suggests sore throats and lumbago, rather than the spiritual elements of bereavement and sorrow. Such a painting is unworthy of his genius. It is a dead thing, for which burial and forgetfulness would be the fittest award.

Mr. E. M. Ward, R.A., has tried his hand at a Shakespearian scene. "Juliet"—*his* Juliet, not Shakespeare's, is in Friar Lawrence's cell, receiving the "distilled liquor," which is to cause "a cold and drowsy humour" to "run through all her veins," so that "no pulse"

> "Shall keep his native progress, but surcease."

Juliet is a difficult character for any artist, histrionic or pictorial, to pourtray. To satisfy the requirements of the story, we must see her not only "rich in beauty," but in that rare and particular kind of beauty which expresses her character. Passionate, impulsive, timid, yet brave; desperate in loving, yet full of maiden modesty and grace. Romeo beholds her full of "Dian's wit,"

> "And, in strong proof of chastity well armed,
> She will not stay the siege of loving terms,
> Nor bide the encounter of assailing eyes,
> Nor ope her lap to saint-seducing gold."

Her passion for Romeo soars above and beyond the sphere of physical attractions. She idealizes his mind as well as his person. After Tybalt's death, when her nurse upbraids her, and exclaims, "Shame come to Romeo," Juliet retorts—

> "He was not born to shame:
> "Upon his brow shame is ashamed to sit,
> For 'tis a throne where honour may be crowned,
> Sole monarch of the universal earth."

Let any visitor to the exhibition keep this delineation in his mind, when looking at Mr. Ward's Juliet, and he will find in

his podgy, wooden-faced girl not a single lineament by which Shakespeare's Juliet should be recognized at a glance. The real Juliet seeks the aid of the Friar to save her from the marriage to which her family condemn her, at any risk. Love has made her bold. She will be "chained with roaring bears;" will be

> "Shut in a charnel-house,
> O'er-covered quite with dead men's rattling bones."

She will do the direst thing

> "Without fear or doubt,
> "To live an unstained life to her sweet love."

Not one glimpse or glimmer of such a Juliet is to be seen on Mr. Ward's canvass. He depicts an affrighted female who might be a provoker of melancholy, but would be a most decided antidote to love.

Mr. D. Maclise, R.A., is another artist who has maltreated Shakespeare in this exhibition. He has chosen a scene with Othello, Desdemona, and Emilia.

> "*Des.* Why is your speech so faint? Are you not well?
> "*Oth.* I have a pain upon my forehead here."

Just before this scene Iago has succeeded with his vile slanders in raising the jealousy of Othello, and his "pain upon the forehead" is the symptom of his mingled rage and grief. Desdemona binds his brow with the handkerchief he had presented to her. He lets it drop, and Emilia steals it, as her husband Iago had requested. This scene might, one should fancy, inspire an artist to pourtray the deep, half-raging, half-doubting passion of Othello, the tender fear of Desdemona, and the vulgar deceit of Emilia. There is some expression in Desdemona's face as depicted by Mr. Maclise—none in Othello's half-hidden countenance that is appropriate to the man or the occasion. The noble Moor might be dark, "black," as he calls himself, but he was a chivalrous gentleman, full of fine feeling, and poetic fancy. In all his chief speeches there is a blending of tenderness and imagination with the rougher nature of the warrior accustomed to "feats of broil and battle;" but none of these qualities are visible in the Othello of Mr. Maclise. He might be a street porter with some commonplace and vulgar grief, certainly not Shakespeare's Othello, whose unaffected narrative of "moving incidents by field and flood," made the high-born Venetian lady "love him for the dangers he had passed."

This picture is not only deplorably wanting in true conception of the characters, but its composition is unpleasing. The figures are uncomfortably huddled together, and an em-

broidered surcoat of Othello is more conspicuous than its wearer or his wife.

A third, and more recent R.A., very clever in the technicalities of his art, full of talent, destitute of genius, and therefore able without compunction to paint down to the taste of the vulgar rich, has chosen for his theme "King Charles the Second's Last Sunday," a picture for which a perfectly ridiculous price is reported to have been promised or paid. John Evelyn in his *Diary* speaks of "the inexpressible luxury, profaneness, gaming, and all dissoluteness" which characterized the last Sunday of Charles the Second's disreputable life. Towards the close of his reign England was profoundly disgraced by the policy as well as by the personal conduct of the wearer of the crown. Little better than a satrap of Louis XIV., looking to his aid in reducing this country to a despotism, usually neglecting public business, and passing his time in a round of debauchery and licentiousness, the king, as his end approached, was often a prey to melancholy, and possibly of remorse. Surrounded with gamblers and harlots, with a broken down constitution, satiated with vicious indulgence, without a real friend, an honest thought, or an inspiring hope, the last days of the Second Charles were passed in a degradation that no glitter of wine cups could illumine, no court splendours could dignify, and his "last Sunday" on earth, as described by Evelyn, was a scene of vanity and wickedness on which the preacher might dilate. All vile passions and low desires were represented at Whitehall on that occasion. Woman was there in a moral abasement, made all the more conspicuous by the mingled costliness and indecency of her costume; man figured as a beast, led by the two attendant demons, Licentiousness and Profanity. Revelry stifled conscience, lust smothered reason, —the devil seemed triumphant, but the avenger was nigh. Death was at work on the disreputable hero of the disgraceful scene, his seal was on his victim, and in six days the guilty monarch had to render his account of deeds done in the body—nearly all of shame.

A great artist is a great thinker, and such an one could only have selected such a theme for the purpose of contemplating it from a moral and ideal point of view. Why paint twenty dead and forgotten courtiers round gambling tables that have long mouldered into dust, except to show the stormy passions that attend such a career—recklessness, greed of unhallowed gain, violent disappointment, bitter remorse, and grim despair. These are the feelings which a great artist would bring before us in all their force and horror, if he obtruded a party of gamesters on our view; and if he depicted harlots at their revels, and a monarch sullying his crown in

their company, could he by possibility forget the bitter fruits that vice produces, the dramatic contrasts between the phantasmal pleasures of licentiousness, and the grim, stern realities to which they lead? Mr. Frith has painting power and drawing power, colour perception to a moderate extent; but thinking, reflecting, and idealizing faculties in very feeble force. His conception of the last Sunday of Charles the Second is vulgar and commonplace. Hampton Court supplied the portraits and the costumes; his own skill has grouped the various figures pretty well together, but the picture has no soul in it. His gamblers have no variety of expression; his Charles the Second looks hearty and well contented, as if lust had agreed with him, and promised length of days; his loose women are all flourishing, the revel successful, with nowhere an intimation of the fallacious character of mere animal enjoyment. He may reply that good for nothing people do often make themselves very comfortable, and we grant the fact; but a great artist would not paint them simply to show that fact. The only justification for a true artist dealing with such subjects is his capacity for seeing further and deeper into character, conduct, and its results, than ordinary mortals can realize without aid. Mr. Frith has in his mind evidently nothing more than the rudest externalities and upholsteries of such a scene, and so his picture, technically clever, is æsthetically good for naught.

By introducing John Evelyn surveying the scene with a wobegone, methodistical countenance, Mr. Frith may suppose he has made his canvass "point a moral;" but Nature does not inculcate her lessons in this commonplace way. What a looker-on thinks of vice is of less consequence than what vice is, and whither it leads; and the collection of reprobates at Whitehall must, in their own persons, have made the ignominious failure of their lives, and the certainty of retribution, more conspicious and repulsive than could be effected by any comments a bystander might make.

It seems as if putting Shakespeare in purgatory were a special function, to the discharge of which R. A.'s committed themselves last year. We have had a Juliet scandalized, an Othello travestied, and we have only to go a little further to find a Jessica traduced. Mr. C. W. Cope, R.A., is the offender in this case. Shylock is giving her his keys, and the Jew and his daughter are the only figures introduced. Whether Mr. C. W. Cope, R.A., ever read the *Merchant of Venice*, we cannot venture to guess. We hope not, because, if he took his Jessica from some bad, second-hand imitation, there may still be some hope for him on his first introduction to the young lady herself; but, if he did read the play, his case must

be desperate indeed. Every Shakespearian reader recollects with delight the exquisite scene in the avenue to Portia's house, where Lorenzo and Jessica enjoy their pretty talk under the bright moon, and Jessica shows wit, culture, and fancy deliciously combined. Mr. C. W. Cope, R.A., has bestowed none of these qualities upon his Jessica, who looks rude as a milkmaid, is dressed in vile taste, and has a chignon behind! It would be the most useless thing in the world to tell such a Jessica that

> "The floor of heaven
> Is thick inlaid with patines of bright gold;"

or to expect her to respond to the statement—

> "There's not the smallest orb which thou behold'st,
> But in his motion like an angel sings,
> Still quiring to the young-eyed cherubins."

The earthy solidity of Mr. Cope's Jessica is proof against such fancies; she has the countenance of a fish girl, and in reply to her lover's poetry might tell him the price of sprats.

The colouring of this picture is ugly, as is its failure in sentiment. Shylock's snuff-coloured gaberdine is not pleasant to look at, and Jessica's dressmakery would put Houndsditch to shame. She is trimmed out in a blue speckly sort of gown, touched up with yellows and reds, and the whole effect is harsh and displeasing.

Another R.A., Mr. S. A. Hart, has sinned against the harmonies of colour in a big picture, representing the submission of Barbarossa to Pope Alexander the Third. The succession of incongruous reds in great patches, including the sprawling emperor, are very disagreeable, and the corpse-coloured pope makes the matter worse. Such a piece may, however, be useful to young colourists, as showing them exactly what they ought not to do. We hope it will operate effectually, and pass it by.

We intended to have said something about the "Hookscapes"—all clever, all mannerized, and all alike in the same sort of red-faced boys, opaque green seas, and impossible cliffs and shores. The best and the worst is called "Mother Cary's Chickens," and will be a favourite with many, though the sea lacks the transparency of water, and the waves are nearly destitute of those innumerable cross lines and curved surfaces in various glittering planes which real waves always present; but we are sick of grumbling, and must look to something we can praise.

Taking the good pieces in the order of the catalogue, we must pay our first tribute to the fine drawing and remarkably

beautiful colouring of Mr. Goodall's "Rebekah," though as a whole, the picture has little hold over our sympathies. Passing by several pieces more or less worthy of note, we reach "The Highland Lass Reading," by the late J. Phillip, painted with that happy mixture of truth and freedom of which he was so great a master. The simplicity and earnestness of the girl's face are charming. A common artist would have made the "Highland Girl" a fine lady; Phillip has thrown over her a rich glow of idealism, without departing from truth. Cooke has given a fine view of "the Canal of the Giudica, in Venice;" and Lee a beautifully painted "Scene on the Road from Funchal, in Madeira," in which the colour of foliage and the effects of light are singularly graceful and true.

The "Jephthah," by Millais, is one of those pictures which, whatever minor faults it may possess, realizes a high conception of the scene, and excites our sympathies by its dramatic power. The chieftain has returned, his daughter has met him, and in deep agony of soul, he exclaims, "Alas! my daughter, thou hast brought me very low, and thou art one of them that trouble me, for I have opened my mouth unto the Lord, and I cannot go back." The revulsion from the triumphs of victory to the heart-broken perception of the fearful cost at which they have been won, is grandly told. Jephthah, anguish-torn in mind, prostrate in body, is presented as an object of even greater pity than his daughter—we feel that he is a victim more wretched than the maid. The attitude of the various figures, and the expression of their countenances, tell the story admirably; and whatever we may think of Mr. Millais' failings, this, like many other of his productions, is full of that genius which places him in the foremost rank.

Next in catalogue order is a widely different class of work; but it is so remarkable for its luxuriant brilliance of colouring that it cannot be passed by—we mean Miss Murtrie's beautiful flower piece, "Margaret's Corner," a very gem in its way, though an awkward companion for pictures painted in a lower key.

"Home after Victory," by S. H. Calderon, has fine qualities, but it is too "stagey." A knight in armour returns to his castle; his father stands with outspread arms to receive him, and his mother and wife have rushed forward, and are clinging to his arms. The face of the knight is not up to the mark in point of expression. He does not come near Wordsworth's "Happy Warrior," but the piece as a whole is good, and it is evident that Mr. Calderon thinks out his subjects before putting them on his canvas.

Mr. Faed has a piece of his usual merit. "Old Life" is a good specimen, but it is too prosy to take first rank. Mr.

Marks is remarkably clever, though verging too much on caricature in "Falstaff's Ragged Regiment;" and Mr. Stone has given a pleasing picture of Nell Gwynne, in the days of her orange-girlhood, giving fruit to an old soldier.

We now come to the most beautifully painted picture in the exhibition—the "Rachel" of Mr. F. Goodall, remarkable for its finished, accurate drawing, and for its mastery over difficulties of colour. "Rachel"—we do not know that we identify her particularly with the Bible character—is descending the steps of a well with a pitcher on her shoulder. The light glows on her rich brown complexion, falls softly on her amber-toned drapery, and gives a singular beauty to her finely-moulded arm. The perfect roundness of the limbs, the swelling of the muscles, and the strikingly natural way in which, while they stand out against the sky, their edges soften into it, are great triumphs of technical art. The colours are peculiar, and remarkable for that delicate combination of richness and softness which have characterized Mr. Goodall's productions since his Egyptian tour. The sky has a greenish-blue tint; the girl is partly enveloped in a soft yellowish-tinted robe, sparingly relieved by a narrow red girdle, and a blue and red stripe in the border. The sunlight falls with a mellow richness seldom equalled; it absolutely glows on the dress, and the soft transparent shadows seem to move as the spectator gazes upon them. Very rarely has an English artist produced so exquisite a work, and we are glad to learn that it has realized a price seldom given for a single figure. We should like to see Mr. Goodall in a more dramatic style. He calls this figure "Rachel," but many other names would do as well. It is evidently true to nature; but it is not specially true of any particular personage in story or song.

No visitor to the exhibition can fail to notice Mr. Carter's sheep skurrying away from a wolf, and starting out of the frame, as if in full tear towards the spectator, and ready to plump down from their place over the door of the west room. This picture is a clever specimen of this particular perspective, and the animals are full of vigour and expression.

Mr. J. T. Linnell has a fine picture, called the "Mountain Road," but, as usual, mannerised, and we miss amongst the landscape-artists any one who has successfully entered on a new path. Of graceful pieces, like Lee's "Salmon Poachers Discovered," several might be named; but a grand and natural style of landscape art seems not at present to exist amongst the various candidates for fame. Mr. Vicat Cole has, however, made a handsome departure from the conventional methods of marine painting, and the play of light on the yesty sea depicted in No. 489 is very fine. This sea has evidently

been studied in the right way. Mr. Cole has looked at nature, while very clever Mr. Hook finds his seas in his "inner consciousness," just as the German philosopher constructed his camel out of the same material, without prejudicing his mind by attention to the reality. It is astonishing how many artists, and even clever ones, seem incapable of seeing the variety of nature. They hit upon a conventional mode of depicting rocks, trees, men, and women, as the case may be, and it never occurs to them that no lofty function of art can be performed by the endless repetition of the same idea. The ablest of this school of error are the Linnells and Mr. Hook. Their talent makes them mischievous, for though few attempts may be made to imitate their particular and objectionable mannerisms, they make the vice of mannerism more respectable than it would otherwise seem.

GRAPTOLITES: THEIR STRUCTURE AND SYSTEMATIC POSITION.—PART II.

BY WILLIAM CARRUTHERS, F.L.S.

(*With a Plate.*)

Classification. The generic name *Graptolithus* was established by Linnæus, as we have seen, for a heterogeneous group of objects, among which a single form of the fossils to which the name is now referred, was placed by him only in the last edition of the *Systema Naturæ,* which had his editorial superintendence. The difficulty of confining this designation to one of the various items included in the genus, and especially of applying a word to these organic remains, which its author employed to indicate that the species included under it were imitations of and not real fossils, presented itself to those who after Linnæus studied this family. Nilsson proposed the name *Priodon* for the true graptolites, but as this word had already been given by Cuvier to a genus of fish it was withdrawn, or, rather, slightly altered into *Prionotus.* This new form of the word was first published by Hisinger, in his descriptions of the fossils of Sweden, in 1837. Before this, however, Brown (1835), had published the name *Lomatoceras,* but with a strange fatality he fell into the same error as Nilsson, having overlooked that this name had already been employed for a genus of insects. The original name was restored by Murchison in his *Silurian System* (1839), in a slightly altered form (*Graptolites*), a spelling which has been universally followed by British authors. In the same work, however, Dr. Beck's note

on the family is introduced, and he retains the word according to the original Linnæan spelling, in which he is followed by writers abroad. Under this name all the numerous and varied forms were included which had been described by Hisinger, Murchison, Portlock, Hall, Geinitz, and others.

Barrande, in his valuable memoir on the graptolites of Bohemia (1850), first subdivided the genus. He established the new genera—*Rastrites*, for species with the cells separated by distinct interspaces on a slender axis (Plate I., Fig. 17; Plate II., Figs. 9 and 10), and *Retiolites* for a somewhat anomalous form without a central solid axis (Plate I., Fig. 12). He further divided the restricted genus *Graptolithus* into two sections, the one *Monoprion*, characterized by possessing a single series of cells (Plate II., Figs. 1, 3, 7, etc.), and the other *Diprion*, having a double series of cells (Plate II., Figs. 2, 4, 5). M'Coy in the same year gave these sections a generic value, retaining the original name for Barrande's *Monoprion* group, and proposing the name *Diplograpsus* for the species included in the section *Diprion*.

Barrande, accepting Hisinger's determination, considered the *Priodon sagittarius* of that author the same as *Graptolithus sagittarius*, Linn., and consequently held the species with a single series of cells to be the true Linnæan type of the original genus. He further endeavoured to show that *G. scalaris*, Linn., was a "scalariform" impression of a single-celled species, and by an oversight which is remarkable in a work specially characterized by the careful and accurate observation that distinguishes all the labours of its illustrious author, he figures a double-celled graptolite as the "scalariform" impression of two single-celled species, viz.: *G. nuntius*, Barr., and *G. Halli*, Barr., as has been already pointed out by Hall. M'Coy, influenced by similar considerations, erroneously retained the Linnæan generic designation for the single-celled forms. Were it not that he has been invariably followed, I would venture to restore the name given by Linnæus to the only form with which he was acquainted; but this would introduce into the accepted nomenclature so many changes without corresponding advantages, that the strict application here of the law of priority would scarcely be justified.

Suess, in 1851, added the synonym *Petalolithus* to M'Coy's genus *Diplograpsus*.

In the same year M'Coy further separated a well-marked group of species, in which the polypary consists of two simple branches, from his restricted genus *Graptolites*, for which he proposed the name *Didymograpsus* (Plate II., Fig. 12), and in the following year Geinitz applied the title *Cladograpsus* to the same. Unaware that this name had been employed, I pro-

posed it in 1858 for a repeatedly branching form, which I detected in the shales of the south of Scotland. While the paper in which I described this and other forms was passing through the press, I learned that Geinitz had used the name, but as I was unable to ascertain to what group he applied it, I permitted the name to stand. In the same paper I described a new species of *Didymograpsus*. As I applied the name obviously to a different group, it must, following the ordinary rule in such cases, be retained for the forms to which I applied it. This is a slender graptolite, looking like a pencil line drawn in beautiful curves, or in nearly straight lines on the surface of the laminæ of the shale in which it is preserved. The numerous branches are arranged sub-symmetrically on the two sides of the primary point.

Salter, in 1861, described a compound form from the Skiddaw slates, similar to some that had already been observed in Canada by Sir William Logan, to which he gave the name of *Dichograpsus*. The fragments of this genus cannot be distinguished from imperfect specimens of the limited genus *Graptolithus*, but the discovery of the beautiful examples found in Canada, and even of the less perfect ones obtained from Cumberland, show that the complete organism was somewhat complex. They were developed symmetrically from a primary point, which Hall calls the "radicle," and dividing more or less frequently in a dichotomous manner, they terminated in greatly, apparently indefinitely, produced, simple, one-celled branches. The slender bases of the branches at the centre of the organism was supported by a flat, corneous disc.

Hall, in 1857, established the genus *Phyllograptus* for a remarkable form consisting of four series of cells, united to each other by their longitudinal axes. In subsequently published papers he proposed several additional genera for organisms found in the Quebec rocks, some of which most probably belong to other families than the graptolites. In some he can detect no cell openings, and *Inocaulis*, which is not rare in our British Silurians, has a solid homogeneous structure very different from that of any graptolite. One of his new genera is represented in Britain by two species, *Dendrograptus*, a remarkable form in which a common stem to the polypary is produced, apparently as in the recent *Halecium*, by the aggregation of numerous tubes, which are the non-polypiferous basal extremities of the branches. He has also established two new genera for organisms that had found places in already established genera. In *Diplograpsus* the polypites were contained in distinct hydrothecæ (Plate II., Fig. 5); but in a few species the cells bearing the polypites were excavated in the margin of the common polypary (Plate II., Fig. 6), and for those

having a structure so very different, he proposed the name *Climacograptus*. The Linnæan *Graptolithus scalaris* belongs to this restricted genus, and Hall, who was aware of this, recognized the original specific designation in proposing the new name. He is not, however, aware that he is here dealing with the only species which Linnæus knew, but, like all other writers, he erroneously considers Hisinger's *Priodon sagittarius* to be the Linnæan type of the family.

Some species of *Didymograpsus* have this polypary extended into a double-celled prolongation below the point of union of the two diverging branches (Plate II., Fig. 13), and these Hall names *Dicranograptus*, chiefly, however, because they have, as he thinks, the same remarkable structure as *Climacograptus*.

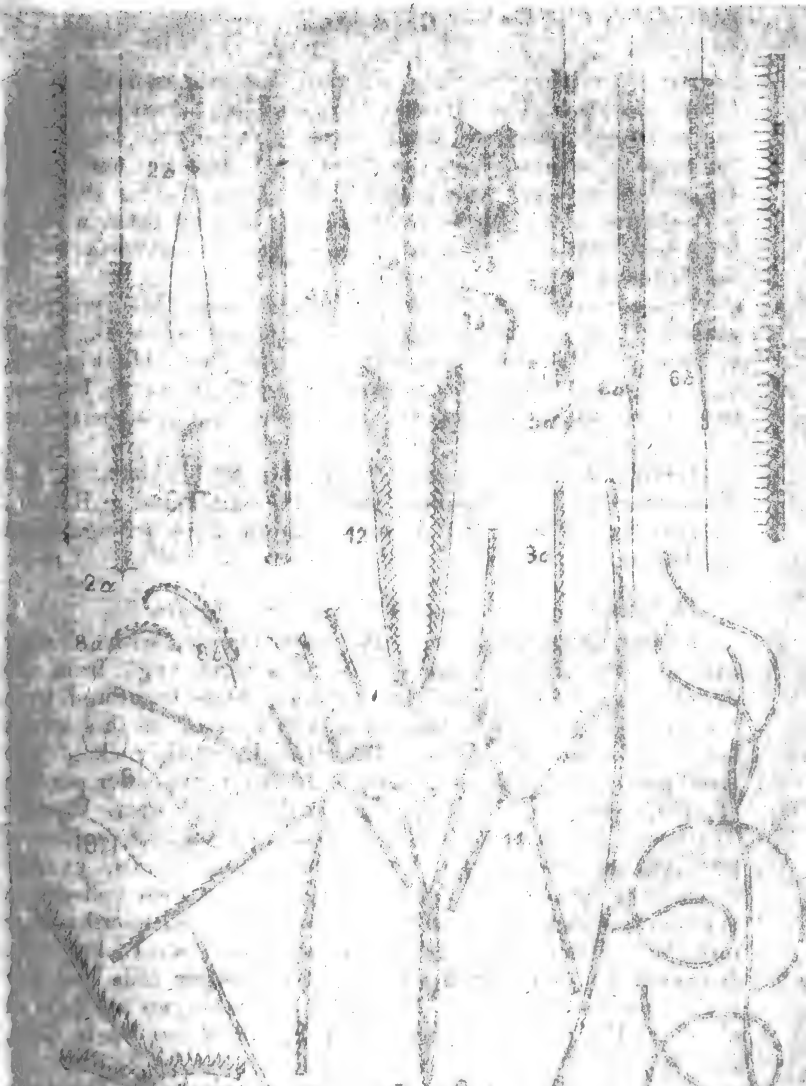
Having thus traced historically the establishment of the different genera of graptolites that have been found in Britain, we shall better understand their relation if we arrange them in systematic order.

SECTION I.—*Species with a single series of cells.*

1. *Rastrites*, Barrande. Polypary simple, with slender tubular cells, rising more or less at a right angle from the delicate capillary axis, and having their bases separated by a considerable interval. There are five species of this genus found in Britain, all of them from the Llandeilo rocks. The fossil named by Harkness, *R. triangulatus*, is the older portion of *Graptolithus convolutus*, His. (Fig. 15). Prof. Wyville Thompson has pointed out to me that the earliest portion of this species was composed of distant tubular cells, exactly resembling those of *Rastrites*. I find in my own collections specimens which confirm this opinion. The cell mouths were furnished with two spine-like appendages (Plate I., Fig. 17). It cannot be determined whether these larger cells had any special functional office to discharge. Two species are figured on Plate II., *R. Linnæi*, Barr., Fig. 9, and *R. capillaris*, Car., Fig. 10.

2. *Graptolithus*, Linn. Polypary simple, with the cells rising at an acute angle, and in contact throughout more or less of their length. Fourteen British species are known, the majority from the Llandeilo rocks, four from the Caradoc, and one, *G. priodon*, Bronn, rising up into the newest beds in which any true graptolite has yet been found—the Ludlow series. Fig. 1 is *G. Sedgwickii*, Portl., originally described from the north of Ireland, but found also in Scotland and Wales. Fig. 3 is *G. Hisingèri*, Car., which is Hisinger's *Priodon sagittarius*. To prevent further confusion, as well as to correct an error, I have set aside the false Linnæan specific

Plate



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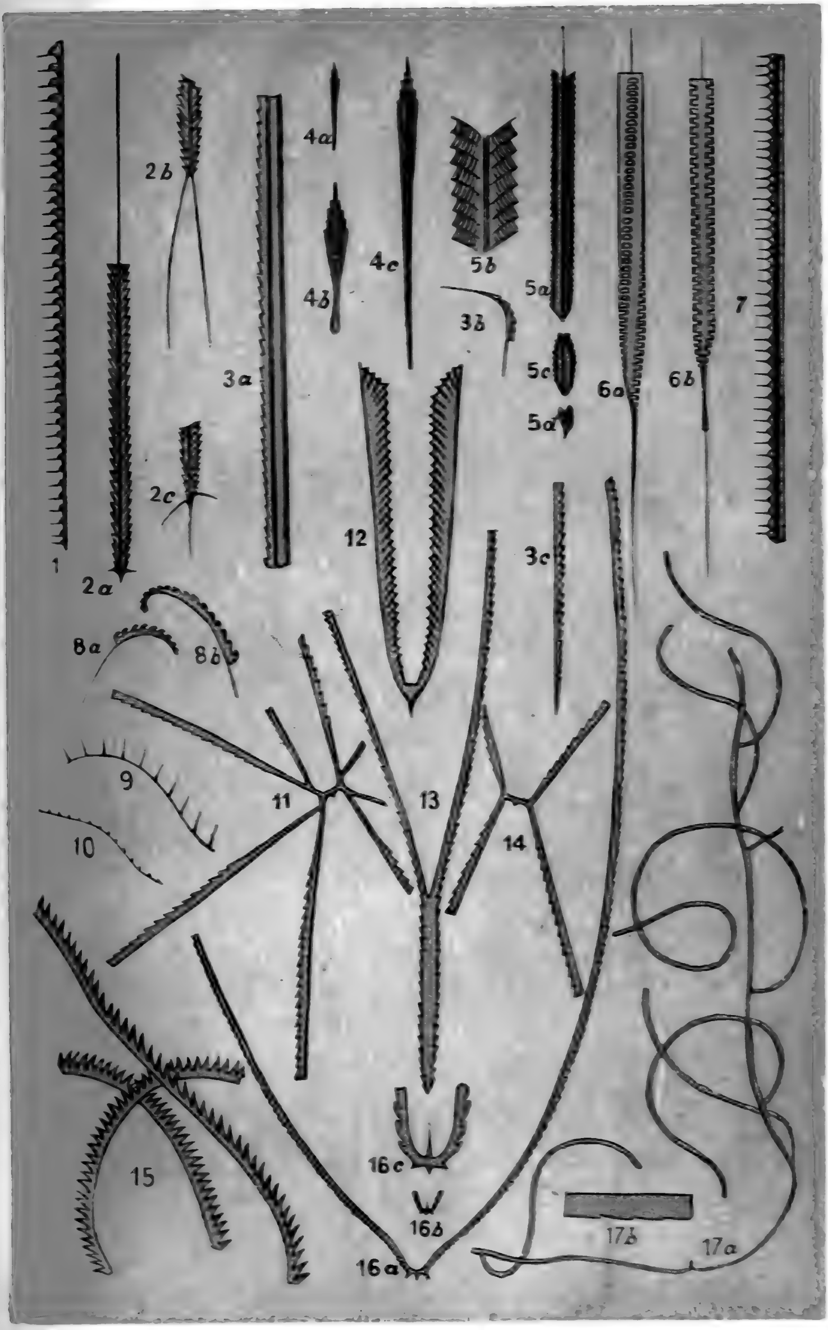
[illegible] with one series of cells.

1. *Rastrites,* Barrande. Polypary simple, with slender tubular cells, rising more or less at a right angle from the filiform solid axis, and having their bases separated by a considerable interval. There are five species of this genus found in Britain, all of them from the Llandeilo rocks. The fossil named by Harkness, *R. triangulatus,* is the older portion of *Graptolithus convolutus,* His. (Fig. 15). Prof. Wyville Thompson has pointed out to me that the earliest portion of this species was composed of distant tubular cells, exactly resembling those of *Rastrites.* I find in my own collections specimens which confirm this opinion. The cell mouths were furnished with two spine-like appendages (Plate II., Fig. 17). It cannot be determined whether these larger cells had any special functional office to discharge. Two species are figured on Plate II., *R. Linnæi,* Barr., Fig. 9, and *R. capillaris,* Car., Fig. 10.

2. *Graptolithus,* Linn. Polypary simple, with the cells rising at an acute angle, and in contact, throughout more or less of their length. Fourteen British species are known, the majority from the Llandeilo rocks, four from the Caradoc, and one, *G. priodon,* Bronn, rising up into the newest beds in which any true graptolite has yet been found—the Ludlow series. Fig. 1 is *G. Sedgwickii,* Portl., originally described from the north of Ireland, but found also in Scotland and Wales. Fig. 3 is *G. Hisingeri,* Car., which is Hisinger's *Priodon sagittarius.* To prevent further confusion, as well as to correct an error, I have set aside the false Linnæan specific



BRITISH GRAPTOLITES.

name, and I gladly find another in the name of the original describer of the species. Fig. 3, *c* is the proximal end of the polypary. Fig. 7, *G. Halli*, Barr. Fig. 8, *a* and *b* are two perfect specimens of a beautiful small species, which at first I referred to *G. millepeda*, M'Coy, but that species is certainly the proximal end of *G. Becki*, and this differs from it in having a very broad common base, from which the hydrothecæ rise. I have dedicated this species to my late friend, J. Morison Clingan, M.A., who was my frequent companion in rambles among the Moffat Hills. *G. Clingani* could not have been part of a compound organism, as Hall supposes, but is evidently complete in itself. Fig. 3, *b* represents a specimen of another species, in which both extremities are perfect; and, though I have never seen large specimens showing both extremities, yet fragments of the ends are not unfrequent, and these conclusively show that the complete organism corresponded in structure with the small and more frequently perfect *G. Clingani*. *G. convolutus*, His., is represented at Fig. 15.

3. *Cyrtograpsus*, Car. Polypary compound; growing in one direction from the primary point. One species only is known from the Wenlock rocks.

4. *Didymograpsus*, M'Coy. Polypary compound; growing bilaterally, and consisting of two simple or double branches. In this genus I include Salter's *Tetragrapsus*, some species of which would, perhaps, better be joined to *Dichograpsus*. Eleven species of this have been observed, all from the Llandeilo beds, except one, which is found in the Caradoc series. Fig. 12 is *D. Murchisonii*, Beck. sp.; Fig. 14, *D. crucialis*, Salt. sp.; and Fig. 16 is an undescribed species from the Moffat shales, for which I propose the name *D. elegans*. A young specimen is figured at 16, *b*, and *c*, showing the "radicle," which subsequently disappears, and the three processes on the convex side, which are always present in this, as in some other species of the genus.

5. *Dichograpsus*, Salt. Polypary compound; growing bilaterally, and branching regularly; the non-celluliferous bases of the branches invested with a corneous disc. Several species of this genus have been found in Canada, but hitherto only two have been detected in the Llandeilo beds of this country, of which *D. aranea*, Salt., Fig. 11, is one.

6. *Clodograpsus*, Car. Polypary compound; growing bilaterally from the primary point, irregularly, and repeatedly branching and rebranching, and without a central disc. Two species of this genus occur in Britain, both in the Llandeilo beds, one of which, *C. linearis*, Car., is figured Fig. 17. It is a very slender species, and the drawing represents it as somewhat too broad.

7. *Dendrograptus,* Hall. Polypary compound, with a thick common stem, giving off branches irregularly, which repeatedly sub-divide in a dichotomous manner. Two species have been noticed in Britain, one from the Llandeilo and the other from the Caradoc beds. Both species are founded on fragments of the polypiferous branches, but these agree so exactly with the species described by Hall, that there can be little doubt as to the genus in which they should be placed.

Section II.—*Species with two series of cells.*

8. *Diplograpsus,* M'Coy. Polypary having a slender, solid axis, and with cells composed of true hydrothecæ. Nine species are known, and all of them from the Llandeilo beds. Fig. 2 represents one of the best known species, *D. pristis,* His. sp. The proximal end is furnished with three spines, all of which have the same origin; the two lateral ones are not the ornaments of individual hydrothecæ, but have the same relation to the general polypary as the terminal one. Different forms of these spines are figured at 2, *a, b,* and *c.* Fig. 5 is *D. folium,* His., which is destitute of any ornament at the proximal end. The individual hydrothecæ are marked by parallel ridges, as if they increased in size, shown in the enlarged portion at Fig. 5, *b.* Small specimens are figured at 5, *c,* and *d.* Fig. 4 represents an anomalous form, *D. cometa,* Gein., having a very small number of cells (3 or 4) on either side of the main axis, and these cells are very much produced, so as to appear almost parallel to the solid axis.

9. *Climacograptus,* Hall. Polypary, having a slender solid axis, and with the cells hollowed out of the body of the polypary. Three species are known in Britain, one from the Llandeilo beds, another from the Caradoc, and the third common to both series. Fig. 6 is *C. scalaris,* Linn. sp., a species which has been rejected by some authors as only a state in which almost any species might occur, and has been by others so misunderstood, that it has appeared under no less than ten different specific names. The relation between specimens preserved so as to show the cell mouths in profile (Fig. 6, *b*), and those exhibiting them in a front view, as transverse or "scalariform" markings on the upper surface, is beautifully shown in a specimen figured (6, *a*), in which the polypary is so twisted as to show the one set of markings on its upper half, and the other on its lower half. I have noticed that the prolonged axis of this species at the proximal end is frequently invested for a short distance by a sheath (Fig. 6, *b*).

10. *Retiolites,* Barr. Polypary without a solid axis, cells rising from a central common canal, and in contact throughout

their whole course; polypary reticulated on the outer surface. Two species of this singular genus have been found in the Wenlock beds of Britain (Plate I., Fig. 12).

SECTION III.—*Species with single and double series of cells on different parts of the same polypary.*

11. *Dicranograptus,* Hall. This is proposed by Hall as a subgenus of *Climacograptus;* but as the form of the polypary has been used by all authors as the principal basis for the separation of genera, this must be recognized as a good genus. A single species, *C. ramosus,* Hall, has only hitherto been described in Britain, and that is from the Llandeilo beds. It is figured (13).

SECTION IV.—*Species with four series of cells.*

12. *Phyllograptus,* Hall. Polypary consisting of four laminæ joined throughout their whole length to a common solid axis, and so giving four separate and independent sets of cells. A single species has been found in the Llandeilo rocks, but I have figured (Plate I., Fig. 5, *a*) an American species and (5, *b*) a transverse section, after Hall, which exhibits, better than the more imperfectly preserved British specimens, the structure of the genus.

Systematic position.—There is, perhaps, no small group of fossils concerning which so many and so different estimates as to their systematic position have been entertained. Linnæus, as we have seen, considered that the species which he knew was not a true fossil. Bromel, as early as 1727, is believed to refer to graptolites in his account of the fossils of Sweden, when he speaks of the fossil leaves of grasses; their vegetable origin has been maintained by several subsequent writers. Brongniart includes them among the Algæ, and figures two species in his great work, *Histoire des Végétaux Fossiles;* and in this opinion he was followed by several of the earlier American geologists, as Mather, Conrad, and Vanuxem.

As equally erroneous, the opinions of Boeck, M'Crady, and Nimmo may be at once set aside. Boeck considers them to have been hollow tubes, rent asunder in different ways before being buried in the mud in which they are preserved. They were probably, he thinks, the arms of radiata or cephalopoda, and the various forms described as different species are the result of the accidental tearing, and the irregular contraction of the substance of the tube. M'Crady considers that the graptolites are the larvæ of echinoderms, because of their similarity in form to Müller's published drawings. Nimmo thinks they are nothing more or less than the serrated spines of the *Raja pastinaca,* or an allied species. It does not appear

from Nimmo's notice that he had ever seen a graptolite, and his absurd conjectures may be excused, while the folly of its publication evidently rests with the then editor of the *Calcutta Journal.* M'Crady and Boeck, on the other hand, came to their conclusions after examining specimens; but the descriptions already given of the structure and general form of these fossils render it unnecessary to refute such notions.

Walch is the first naturalist who recognized the animal nature of graptolites. In his work on the fossils of Knorr's Museum, he figures two species, which he describes as small toothed orthoceratites. The one is most probably *G. priodon,* preserved in the round, represented externally in one figure, and in section in the other. Geinitz has mistaken the dark-coloured divisions between the cells shown on the surface of the polished slab for specimens of *Rastrites peregrinus.* The other species figured is *G. convolutus.* Walch's opinion that they were minute cephalopods was entertained by many naturalists, among others by Wahlenberg and Schlotheim. Barrande at length set the matter at rest by clearly showing that they could not structurally belong to this group, but must be zoophytes.

Nilsson, the venerable Swedish naturalist, was the first to suggest their true affinities. Some thirty years ago he was engaged in the study of these fossils, and published an abstract in anticipation of a complete memoir, which he has never given to the world. At that time the classification of zoophytes was very imperfect, and in the family Ceratophyta, to which he referred them, were included a number of organisms now known to have no affinity with each other. Beck, in a note in Murchison's *Silurian System* (1839), refers them to the neighbourhood of *Pennatula,* and he has been followed by Barrande and others. The possession of a solid axis, and of a free polypary, are the points chiefly relied on by those who maintain this view. M'Coy thinks they were Sertularians, because the form of their horny polypary and the polype cells were the same as in that family. Salter, Greene, and others would raise them much higher in the scale by placing them amongst the *Polyzoa.*

In trying to estimate, if it be possible, which of these opinions is the most accurate, it will be necessary to ask first, what are the characters to which we have access in graptolites that are most important in throwing light on their systematic position. Some make the general form of importance; but, on the one hand, this is one of the most variable characters in the same family, and on the other, it is one which repeats itself in very different families. It would be impossible to distinguish between the *Hydrozoa* and the *Polyzoa* from general

form. Besides, we find this very variable amongst the graptolites themselves. Nor is the fact that the polyparies were free of much significance, inasmuch as there are free forms among both the *Polyzoa* and *Hydrozoa*. The only trustworthy characters for the purpose we want are to be obtained, I believe, from the structure and relation of the individual parts of the polypary. In the *Polyzoa* there is a distinct septum cutting off the individual from the common canal, except by a comparatively small perforation. In the *Hydrozoa* the polype rises directly from the cœnosarc, and this also is the structure of the graptolite. This would, then, at once set aside the *Polyzoa*, and restrict the inquiry to the humbler cœlenterate zoophytes. The general resemblance between the free *Pennatula*, with its prolonged axis and bilateral arrangement of parts, and *Diplograpsus*, will not bear even a little scrutiny. The axis is slender and corneous, and is produced at the distal end of the organism, while in *Pennatula* it is thick and fleshy, and proceeds from the proximal end. The cells containing the animals are dug out of the cœnosarc, and strengthened with calcareous deposits in *Pennatula*, while in the graptolites the polypary is corneous and external, agreeing in this respect also with the *Hydrozoa*. There are, no doubt, some structures for which it is difficult to find anything corresponding among the *Hydrozoa*; but making every allowance for them, and considering the many and important points which they have in common, there is a strong case made out for the graptolites being *Hydrozoa*, although a somewhat abnormal form.

EXPLANATION OF PLATE II.

Fig. 1. *Graptolithus Sedgwickii*, Portl.

Fig. 3. *Graptolithus Hisingeri*, Car. *a*, portion of the adult polypary; *c*, proximal end, with small cells; *b*, young specimen of an allied species.

Fig. 7. *Graptolithus Halli*, Barr.

Fig. 8. Two perfect specimens of *Graptolithus Clingani*, Car.

Fig. 15. Fragments of *Graptolithus convolutus*, His.

Fig. 2. *Diplograpsus pristis*, His. sp. *a*, complete polypary; *b* and *c*, different forms of the proximal spines.

Fig. 4. *Diplograpsus cometa*, Gein. Three different forms.

Fig. 5. *Diplograpsus folium*, His. sp. *a*, complete polypary; *b*, portion magnified; *c* and *d*, young individuals.

Fig. 6. *Climacograptus scalaris*, Linn. sp.

Fig. 9. *Rastrites Linnæi*, Barr.

Fig. 10. *Rastrites capillaris*, Car.

Fig. 11. *Dictrograpsus aranea*, Salt.

Fig. 12. *Didymograpsus Murchisonii*, Beck.

Fig. 14. *Didymograpsus crucialis,* Salt, sp.

Fig. 16. *Didymograpsus elegans,* Car. *a,* portion of an adult specimen; *b,* young specimen, showing the primary point, or "radicle;" *c,* the same magnified.

Fig. 17. *Cladograpsus linearis,* Car. *b,* portion magnified to show the form of the cells.

FLYING MACHINES.

In all ages men have envied the powers of flight possessed by birds, and from ancient to modern times inventors and schemers have busied their brains with devices intended to confer upon humanity the desirable faculty of aërial locomotion. For the most part, such efforts have been made by a class of projectors whose folly and infatuation have thrown ridicule upon the idea. Over and over again, the most absurd contrivances have been represented as sure to achieve success—a little more money was the only thing required; and if a sympathizing public would only find the funds, blundering enthusiasts promised, and believed, that they would fly like jackdaws from the neighbouring steeple, or soar like eagles far above the haunts of men.

The recent establishment of an "Aëronautical Society" in this country, under the presidency of the Duke of Argyll, and with a council containing such men as Sir Charles Bright and William Fairbairn, James Glaisher and F. H. Wenham, has already had the curious effect of raising expectations in scientific minds, that at last some form of flying apparatus may be made to succeed. Of late years, a partial study of the wings of birds, and of their methods of action, seemed to show that flight was a physical impossibility for man. The size of the bird's wing was so large, in proportion to the creature's weight, and it appeared to demand so great an amount of muscular force for its movements, that it seemed perfectly hopeless to expect that human muscles could wield an apparatus of the required dimensions, and with the velocities demanded, or that any mechanism could be constructed generating sufficient force in proportion to its weight. Mr. Wenham's researches into the matter have materially modified the opinions of those who heard his paper read, or who have perused it in the *First Annual Report of the Aëronautical Society of Great Britain.**

He has thrown much light upon that very complicated and

* Published by Cassell and Co.

abstruse question, the flight of birds, and he has established good reasons for supposing that there has been much exaggeration in the popular estimate of the force exerted in the operation. We hope our readers will have recourse to the publication we have named; but, as an incentive to consult it, and for the benefit of those who are not likely to see it, we shall proceed to give a condensed account of its contents. Mr. Wenham tells us that a weight of 150 lbs. suspended from a surface of the same number of square feet, will fall through the air at the rate of 1300 feet per minute, the force expended on the air being nearly six-horse power. Consequently, that power would be required to keep the same weight and surface suspended at a fixed altitude. A man can perform muscular work equal to raising his own weight, say 150 lbs., twenty-two feet per minute; but at this low rate of speed he would require to sustain him on the air a surface of 120,000 square feet, making no allowance for weight beyond his body. Thus, attempts to construct bird-like wings, by which a man could raise himself perpendicularly, appear quite impracticable.

A pelican, shot by Mr. Wenham, on the Nile, was found to weigh 21 lbs., and its wings measured ten feet from end to end. During their flight, pelicans make about seventy wing strokes per minute, and when they float on the air, a few strokes in each minute appear sufficient to sustain them, and there is no symptom of powerful exertion. Mr. Wenham also noticed that flocks of spoonbills, flying at about thirty miles an hour, at less than fifteen inches above the Nile's surface, did not create a sufficient commotion in the air to ripple the surface of the water. Studying the behaviour of an eagle impelled to activity by a charge of large shot rattling amongst his feathers, he also noticed that he had to run at least twenty yards before he could raise himself from the earth. Many other observations of birds are highly important, and enable us to form some conception of the way in which various kinds of wings perform their work.

Citing Smeaton, Mr. Wenham informs us, that if a plane moves against the wind, or the wind against a plane, at the rate of twenty-two feet per second, 1320 feet per minute, or fifteen miles an hour, a force of one lb. per square foot is obtained. When a falling body, having a weight of one lb. to each foot of resisting surface, reaches that velocity, the atmospheric resistance balances its weight, and keeps it from descending faster. A man and a parachute, weighing together 143 lbs., will not fall with a greater velocity if the parachute is kept in position, and has an area of 143 square feet. A fall of eight feet brings a body to the earth with the same velocity, which is not sufficient to destroy life or

limb. Swallows have a wing surface of two square feet to the pound; some of the duck tribe, which fly well, little more than half a square foot, or 72 inches to the pound. If such birds allowed themselves to fall perpendicularly, with outstretched wings, they would reach the ground with an injurious velocity, but by descending obliquely, they alight with ease and safety. This combination of a horizontal motion with a perpendicular one is of the greatest importance; and Mr. Wenham observes, "In the case of *perpendicular* descent, as a parachute, the sustaining effect will be much the same, whatever the figure of the outline of the superficies may be, and a circle affords, perhaps, the best resistance of any. Take, for example, a circle of twenty square feet (as possessed by the pelican), loaded with as many pounds. This, as just stated, will limit the rate of perpendicular descent to 1320 feet per minute. But instead of a circle sixty-one inches in diameter, if the area is bounded by a parallelogram ten feet long by two broad, and whilst at perfect freedom to descend perpendicularly, let a force be applied exactly in a horizontal direction, so as to carry it edgeways, with the long side foremost, at a forward speed of thirty miles an hour—just double that of its passive descent—the rate of fall, under these conditions, will be decreased most remarkably, probably to less than one-fifteenth part, or eighty-eight feet per minute, or one mile per hour." This diminution of the descending velocity is occasioned by the resistance of the mass of air moved by the parachute in its horizontal course, and which necessarily becomes greater in proportion to the width of the parachute.

Among the experimental illustrations suggested by Mr. Wenham is the action of a thin blade, one inch wide and a foot long, fixed at right angles to a spindle on which it can be turned. If such an apparatus is immersed in a stream running in the direction of the spindle, and held at rest, the force which the blade has to resist will be simply that of the water current acting on its surface, and the current will be checked to a corresponding extent. If, however, the spindle and blade are made to rotate rapidly, "the retarding effect against direct motion will now be increased over *tenfold,* and is equal to that due to *the entire area of the circle of revolution.* By trying the effect of blades of various widths, it will be found that, for the purpose of effecting the maximum amount of resistance, the more rapidly the spindle revolves the narrower may be the blade."

It will be evident, that if a column of air were rotating in the same direction and with the same velocity as that of the vane and spindle, the movement of the vane would not be resisted by the air, and just to the extent to which the revolving

vane communicates its own motion to the air, the reaction of the air against the motion of the vane will be lessened. If at each moment of its progress in a horizontal direction the vane acted upon a stratum of air whose *vis inertiæ* had not been disturbed, the maximum of reaction would be obtained. Mr. Wenham, in a very ingenious way, applies these facts to the action of the long wings of swallows, and other birds characterized by the length of their flying apparatus, and he shows very pointedly the great mechanical disadvantage at which a bird or a machine must operate in order to raise a weight *perpendicularly*, as compared with raising it obliquely. He says it does not appear that any large bird can raise itself perpendicularly in a still atmosphere, but pigeons can accomplish it approximately to a moderate height, and the humming-bird, by the extremely rapid vibration of its pinions, can sustain itself for one minute in still air in the same position. "The muscular force required for this feat being much greater than for any other performance of flight. The wings uphold the weight, not by striking vertically downwards upon the air, but as inclined surfaces reciprocating horizontally like a screw, but wanting in its continuous rotation in one direction," and, therefore, with some loss of power from the rapid alternation of motion.

A bird is sustained in the air by the *weight* of that fluid, and the sustaining power of its wings will depend upon the quantity or weight of air that would have to be displaced by its fall. By a wide stretch of wing, and a horizontal motion, the resistance is maximized, and a long-winged bird that has raised itself in the air may avoid falling by maintaining a certain horizontal velocity with a moderate expenditure of force.

A kite is sustained and moved obliquely by the force of the wind, and the weight of the air which its fall must displace. Thus there is some analogy between a wing and a kite, it being mechanically pretty much the same thing, whether a breeze blows against a resisting surface, or a resisting surface is moved against a mass of air. Mr. Wenham cites an experiment of Captain Dansey, in which a kite, having a surface of only 55 square feet, raised a weight of 92¼ lbs. in a strong breeze, and he considers that exploring kites might be safer and more convenient than exploring balloons for purposes of war, though their employment would be dependent on the force of the wind.

Notwithstanding the ingenuity of the preceding explanations, the reader may scarcely be prepared to admit Mr. Wenham's inference, that "man is endowed with sufficient muscular power to enable him to take individual and extended flights, and that success is probably only involved in a question of suitable mechanical adaptations." An imitation of the

bird's length of wing is out of the question, as we have no means of constructing a mechanism equally strong and light, and of similar proportions in length and breadth to the weight that has to be carried. The possible solution of the problem is thus explained. "Having remarked how thin a stratum of air is displaced beneath the wings of a bird in rapid flight, it follows, that in order to obtain the necessary *length* of plane for supporting heavy weights, the surfaces may be superposed, or placed in parallel rows, with an interval between them. A dozen pelicans may fly one above another without mutual impediment, as if framed together; and it is thus shown how two hundred weights may be supported in a transverse distance of only ten feet."

Can any mechanism, either moved by man, or by inorganic motive power, be constructed to operate successfully on the principles thus explained? After carefully reading Mr. Wenham's paper, few scientific men would venture to pronounce the solution of the problem *impossible,* and we have reason to believe it has materially modified the opinions previously entertained by some of our best mechanicians and physicists. The paper is full of close reasoning, and differs entirely from the illogical speculations often put forth by enthusiastic projectors, who set to work according to methods that inevitably lead to failure.

From certain experiments described by Mr. Wenham, the nature of the difficulties to be overcome, and the kind of possibility that may be convertible into actuality, are made clearer than they were before, and many facts discovered of late years in reference to the action of screws as substitutes for paddles in steam navigation, and in relation to the flight of various shaped projectiles, may come in aid of the aëronautist.

It is remarkable that previous to the invention of balloons, flying machines were pet schemes with many philosophers. The gas balloon especially threw them into the shade, but the investigations of the infant Aëronautical Society operate in the reverse direction, and tend to create a belief that if aërial navigation is ever to assume practical importance, it must be through the agency of some mechanism more manageable and less liable to derangement than an enormous bag filled with a material that has the greatest possible aptitude for escaping through the minutest pores.

THE LUNAR APENNINES.—CLUSTERS AND NEBULÆ.—OCCULTATION.

BY THE REV. T. W. WEBB, A.M., F.R.A.S.

We come now to a portion of the lunar surface remarkable for the unusual combination of great altitude, and comparative freedom from that eruptive disturbance which has left its traces so abundantly in other elevated regions. Thus far, it has some similarity with the great mountain-chains of the earth, which it also resembles in its rapid slope in one direction, contrasted with the gradual declivity of the other side. The comparison, however, as Schmidt was the first to point out, fails in one important point here (and such indeed seems to be the case in all the lunar highland districts)—the absence of long valleys, such as either have been cut down by streams of water, or at least are now their recipients: and there is something in the structure of the N.W. edge different from the ordinary terrestrial central crest with its double slope: the massive pedestals of the loftiest peaks arise from it, but the peculiarity of their connection and their local division would, in Schmidt's opinion, scarcely find anything analogous on the earth. This district received from Hevel the designation of the *Apennines*, in accordance with his fancied analogy between the lunar and terrestial surface, and on our index-map is numbered 23. Schr. has ascribed to it a length of nearly 460 miles, with a breadth of 70 to more than 90 miles: B. and M. estimate its area at nearly 74,000 square miles: and though surpassed in height by several ranges upon the limb, it forms the most considerable mountain-mass, in the clearly-distinguishable part of the visible hemisphere. On the E. it connects itself with the conspicuous crater *Eratosthenes* (29), by a narrow prolongation of moderate height: southward it gradually declines in a great number of low ridges into the *Sinus Æstuum* (H), the *Mare Vaporum* (F), and the region about *Manilius* (24): on the W. it borders on the already-described chain of *Hæmus*, extending N.E. from *Menelaus* (15), and the *Mare Serenitatis* (E): on the N. and N.E. it culminates in a long, lofty, steep crest, somewhat curved in its general direction, and much indented in detail; this towers over the Mare Imbrium (I), with many insulated hills and long low ridges attending its base, in places rising towards it in steps, and looking, as Schmidt observes, like great masses of debris detached from the main chain during its elevation; perhaps it may be equally open to us to suppose that they may in part be the result of landslips from its edge at a more recent date. The earliest observers were astonished at

its evident height and precipitousness, and Galileo and Hevel naturally thought it the loftiest of the lunar mountains. Its shadow occasionally, about the time of the First Quarter, cuts out a broad and deep notch of the *Mare Imbrium* reaching to the terminator, and extends for a length of about 83 miles; or, which comes to the same thing, a spectator at that distance would see across the wide-extended plain its crest rising high enough into the sky to cover the disc of the rising sun; as on the other hand, at sunset its summit withdraws into darkness when equally removed from the terminator. About the First Quarter, the broad illuminated line of the main ridge runs out so far into the lunar night, that it may even be distinguished by a sharp eye without the telescope; and though a similar irregularity is obvious when the terminator passes near *Theophilus* (85), yet, according to B. and M., it was the projection of the *Apennines* which led Plutarch, and others of the ancients to infer the rugged character of the lunar globe. Hevel first measured, of course with a very rude kind of micrometer, the distance of the extreme illuminated point from the terminator at the lunar sunset, and found it $\frac{1}{13}$ of the moon's radius,* giving a very fair approximation of 16,800 ft. From its steepness, it is scarcely free from shadow through four days, and the great crest bears traces of it even as late as 24h. before full. During the lunar afternoon and evening, the shadow on the abrupt N.E. descent is replaced by light, and a little before Last Quarter I have seen it, though falling very obliquely to the axis of the chain, reflected from the precipices in a very beautiful and striking manner. The whole mass is comparatively light in colour, unbroken by darkness, excepting where penetrated by deep valleys on the S.; and there being no luminous streaks here, and the *M. Imbrium* being of a deep grey, the *Apennines* can be readily distinguished under the highest illumination. A narrow strip along its loftiest edge reaches 7°—8° of brightness; a suggestive fact, in conjunction with many other instances of the like nature, especially in the rings of craters, and one which would come into consideration in selenological inquiries; though its uncertainty and irregularity occasion difficulty in its interpretation. It would seem as though there must be a difference somewhere, either of material or of structure, in the original formation; or of internal arrangement or reflective power, superinduced at a later period in the process of cooling or consolidation, or from the presence, or relative absence, of some external influence. Among these, singly or in combination, would lie

* Galileo had previously *estimated* the projection of some elevations in various phases at more than $\frac{1}{20}$ of the diameter ($\frac{1}{10}$ of radius). Too large, but not amiss for him.

our choice of an explanation plastic enough to be moulded to the varying and capricious nature of the phenomenon; but there is an *embarras de richesses:* the number of alternatives causes difficulty in selection; and after all, it is not wonderful that we should be perplexed by an appearance which we are obliged to study at a distance, which the highest available magnifying powers can only reduce to 200 or 300 miles. What would be the difficulties and the perplexity of the geologist if he were obliged to study the structure of the earth from a corresponding remoteness, and in equal ignorance of its materials, the processes to which they have been subjected, and—save only in very rude outline—the causes and mode of their present conformation! However, this subject of varying reflective power or *local colour* deserves, and we may hope will some day receive, a greater amount of separate investigation than has yet been accorded to it.

"Almost numberless," say B. and M., "is the multitude of mountain ridges, separate peaks, and hills which cover the highland; and even with the strongest telescopic aid and the most invincible application, a delineation, entering as much into detail as is practicable, for instance, in the great *maria,* would here be unsuccessful." They say that their map contains on the W. of the crater *Conon,* that is to say, in about $\frac{1}{3}$ of the whole length of the chain, towards 500 summits, but that 2000 or 3000 would not have been enough to exhibit all which can by degrees be made out here under favourable circumstances. "A three times larger scale, a gigantic telescope, and the special examination of years, would be requisite to produce a representation approaching in accuracy to one of our better terrestrial maps."

This complexity of structure had been noticed by Schr., whose 27f. reflector, with a power of 200, had shown him in 1795-6 the innumerable minor elevations of which the great masses are compacted together, in, so to speak, tangible distinctness, though in part as minute as the smallest pins' heads; the labyrinth, in fact, is not difficult to be perceived; and I have seen something of it with a $3\frac{7}{10}$ inch object-glass.

Beginning on the S.W. from the end of *Mt. Hæmus,* which forms the S.E. border of the *M. Serenitatis,* we come first to the gradual ascent of a wide-spread plateau, 180 miles from N. to S., and 165 in the opposite direction; an extent of which we may get an idea by comparing it with the distance from London to York, between 170 and 180 miles direct. The general elevation of this mass may be perhaps 6000f., much greater than the subsequent rise of the summits, which it bears. The arrangement of most of these shows one of the peculiar parallelisms of the moon, from N.E. to S.W.: one

point among them reaches 8000f. The N. part of the *Apennines* is by far less connected with loftier and more insulated peaks: we find here a crater, *Aratus*, of great depth (Schr. thinks 3500f. or more) for its diameter of 7 miles; its 8° of brightness make it conspicuous even in the full moon; a summit close to it on the N. rises 10,400f. above the highland 30 miles to the W.; and another further to the N.W., visible from the plain towards the sunrise, mounts above that level to 14,300f. A short distance N. of *Aratus*, a high bright ridge in a meridian direction forms for some length the shore of the *M. Imbrium*. It was named *Hadley* by Schr., who gave it 13,400f. above the plain beneath; B. and M., 15,200f. —this latter about the same as our Monte Rosa, but with a far finer uprising from the neighbouring level. A summit further S.E. was measured by Schr. at 12,600f. The extreme N. termination of the *Apennines* (*Hadley β*, B. and M.) lies somewhat further out;—an insulated headland of 8500f., commanding a grand prospect over boundless plains through a great part of the horizon, broken in the N. by the extreme peaks of the *Caucasus*, and further E. by the great wall of *Aristillus*, and contrasted with the huge masses of *Hadley* on the opposite side. Rounding this promontory, and keeping along the edge of the *M. Seren.*, we come to another considerable mountain (*Hadley* Γ) worthy of notice, as the nearest vantage-ground commanding a view of the mysterious *Linné*, of which so much has lately been said, and overlooking perhaps at the present moment, though from a considerable distance, some of those wonderful processes by which the God of nature modifies the results of his own creation.

This N. section of the Apennines contains more craters than the other parts; they are all small, bright, and very regular and sharp. One lying between *Hadley* Γ and *Aratus*, and marked 84 by Lohrm., is so conspicuous, that its omission by Schr. might lead to the idea of recent formation, had not the experience of the last few years fully proved the insecure nature of all such inferences. They are, however, of use so far as they tend to a closer examination of suspected districts.

S.E. from *Aratus* lies a larger crater, *Conon*, the principal explosion-centre of the region; 10 miles in diameter, and, according to Schr., nearly 3500f. deep; B. and M. think more. A central elevation was seen by all these observers, as well as by myself with an inferior telescope; it was, however, missed by Lohrm., who, on the contrary, stands alone in mentioning a pass through the S. part of the ring, containing, a little way out, a minute crater. B. and M. differ also from him in asserting the ready visibility of the crater in the full moon—trifles of detail, which may *possibly* be some day found more

significant than they now appear. Chains of hills branch off from the neighbourhood with the usual S.W. parallelism nearly to *Manilius*, and the profusion of slightly curving ridges to the S. is said to produce a beautiful effect.

Immediately N. of *Conon* we find another of the great summits of the principal chain, *Bradley* A, which towers over the *M. Imbrium* to a height, according to Schr., of 16,250f., overtopping by several hundred feet, and greatly surpassing in relative height, the monarch of our Alps. It sends down a bright spur into the plain; and some long low ridges at its foot have a direction not parallel to the grand chain, but nearly at right angles to it, and pointing to the magnificent ring-plain *Archimedes* (33). Further S.E. is the rival summit *Bradley*, which, however, falls short of its neighbour by nearly 300f.; B. and M. give it but 14,400f. These masses stand in superb relief near the terminator.

The next eminence towards the S.E., after crossing a depression, is *Huygens*, the supreme culminating point of the whole chain; unless, as Schmidt remarks, there may be still loftier summits in positions further from the escarpment, where they would cast no measurable shadow. It is a ridge about 46 miles in length, commencing on the N. with a steep promontory, bearing a peak of 14,600f. (15,400 Schmidt), and rising gradually to a height, according to B. and M., of 18,000f. There is a difficulty in the measurement, owing to the interfering shadow of another promontory on its E. side (*Huygens* A, 12,250f.), and thus they explain the difference between their value and the 20,900f., the mean of four good measures by Schr., who also found 21,600f. by Hevel's method. Even at the lowest estimate, this is a colossal height, which, especially as taken in connection with the vicinity of the plain beneath, greatly overtops all the magnificence of Switzerland. On the very loftiest point is a minute deep white crater, detected by Lohrm.; but not a difficult object, as I have seen it with $3\frac{7}{10}$ in., and a power of 144. Such an arrangement is exceptional on the moon, and, as Schmidt observes, occurring on the summit of a long ridge, bears no analogy to the terrestrial crater at the apex of a cone.

"The magnificent clearness," say B. and M., "with which this whole steep edge presents itself at the time of the First Quarter in a bright telescope exceeds all description. Islands of light innumerable, each still more minute than the preceding, rise up out of the black lunar night, and the scene changes itself under the observer's eye, as new points are constantly becoming visible, while others are increasing and uniting themselves with their neighbours into long shining ridges."

At some distance S. of *Huygens* lies *Marco Polo,* an oval depression in the high ground, without a ring, visible chiefly in the wane, and remarkable as the centre of convergence of a number of narrow valleys. N. and N.W. of it the hill-grouping is beautiful.

The eastern part of the *Apennines* is much of the same character: a plateau covered with slightly connected ridges and chains of hills, running chiefly parallel in a S. direction. Its edge towards the *M. Imbrium* still nowhere descends below 6400 feet; a lower chain runs parallel to it through the plain at eighteen miles distance. Towards its S.E. extremity rises an almost separate mass, bearing numerous peaks, some of which attain 11,500 feet, and at this place it turns back at right angles to its previous direction, to form the N.W. shore of the *Sinus Æstuum* (H). Beyond the angle, however, and beyond some narrow gorges uniting the two plains, the original range reappears in a small, nearly rectangular plateau, whose summit, *Wolf,* attains, according to Schr., 11,700 feet (B. and M., 11,000 feet). Then a narrow and interrupted chain of inferior eminences stretches on in advance like a row of gigantic stepping-stones, till it forms a singular connection with the wall of the great crater *Eratosthenes* (29), and so brings to an end one of the most magnificent as well as extensive mountain masses of our satellite.*

CLUSTERS AND NEBULÆ.

The time of year has now become unfavourable for the examination of the fainter objects in the heavens, and those which we are going to mention ought to have been pointed out earlier. However, they may still be found in clear and moonless nights, and the knowledge of their position will prepare us for another examination under more advantageous circumstances. The first is in a space so barren to the eye that, unless we possess the convenience of divided circles (when we should find it in R.A. xiiih. 36m. D.N. 29° 1′), we must pick it up by sweeping. It lies about one-third of the distance from *Arcturus* to *Cor Caroli,* and not much out of the line; and if this part of the sky is carefully traversed, our finder will soon come across a misty speck, which in the telescope will fully reward our pains. It is

41. *The great cluster in Canes Venatici.*—Gen. Cat. 3636.—M. 3. Smyth describes this as a brilliant and beautiful congregation of not less than 1000 small stars, 5′ or 6′ in diameter, blazing splendidly towards the centre, and compressed on the *sf* side, as having no outliers there;

* B. and M. observe a considerable and unusual difference between their map and Lohrmann's "Section" throughout this intricate region.

somewhat resembling the luminous *Medusa pellucens.* H. calls it a most superb object; the stars, which he rates at 11—15 mag., form radiating lines and pointed projections from the mass, with many stragglers; and such was the power of his $18\frac{1}{4}$-inch mirror with front view, as to resolve it entirely, "when not a star near it, even *Arcturus*, was visible to the naked eye for clouds." With a $3\frac{7}{10}$-inch achromatic aperture I found it, though a beautiful object, hardly resolvable; but its recent aspect with a $9\frac{1}{4}$-inch silvered speculum was different indeed. There the resolution is carried very far, so that, not having looked at the preceding descriptions, I did not notice the blaze, and thought the increase of central density not greater than would be produced by an equidistant arrangement in a sphere, enclosed, however, as it would seem, by a more sparse and irregular stratum on every side. But what struck me most, in an independent observation, was the contrasted magnitudes of the stars; two sizes at least were very evident, perhaps $10\frac{1}{2}$ and 12 or 13m. of Sm.'s scale. And it was not less certain that the arrangement of the larger stars had no reference to central condensation; they were sprinkled alike through (or in front of) the mass and among the extreme outliers. Their very aspect, as well as the concurring testimony of H., would prove that the difference of magnitude was a fact, and not, as he has stated in a case to be mentioned hereafter, an illusion depending upon the concurrence of several minute stars in the same visual line. The possessors of powerful instruments may be interested in knowing that 2 or 3 m. (of R. A.) *p* is a small star, which Sm. and H. found with the great reflector to be "a fine first-class double star."

We must adopt a similar process of sweeping (if we cannot point to R. A. xiih. 45m. D. N. 41° 50′) about $2\frac{1}{2}$° *n* a little *p*, from *Cor Caroli*, to find

42. Gen. Cat. 3258.—M. 94. Sm. describes it as large and bright, brighter towards the middle, with evident symptoms of being a compressed cluster. H. calls it "a very interesting object, being a nebula very suddenly much brighter in the middle on a great scale," the nucleus being 10″ or 15″ in diam. with a light equal to a 9 mag. star. It had glimpses of stars, and was not resolved but resolvable. With my $3\frac{7}{10}$-inch aperture it was like a beautiful comet; a power of 212, on $9\frac{1}{4}$ inches of silvered glass, led me to think it resolvable.

Our next will be found thus: run a line from *Arcturus* through *η Böotis*, the 4 mag. star nearly W. of it, bend it gently upwards, and carry it rather more than twice as far again; it will fall upon another 4 mag. star, *ν Comæ Berenicis;* about 1° *f* a little *n* of this we shall get in the finder a misty spot, which is

43. Gen. Cat. 3453.—M. 53. "A highly compressed ball of stars," Sm. 11—15 m.; blazing in centre. H. calls it a most beautiful cluster, "with curved appendages, like the short claws of a crab, running out from the main body;" 5′ in diam., a few stars 12 mag., the rest of the smallest size, and innumerable. But to see it thus requires considerable advantages. With $3\frac{7}{10}$ inches I found it neither very large nor bright, and not very resolvable; the $9\frac{1}{4}$-inch mirror, however, masters it, showing not much central compression and many outliers, among which, as in the case of M. 3, are many of the brighter stars, there being evidently several magnitudes. A low power shows a pretty open pair *s*. Sm.'s remark upon this cluster may well be transcribed here: "the contemplation of so beautiful an object cannot but set imagination to work, though the mind may soon be lost in astonishment at the stellar dispositions of the great Creator and Maintainer. Thus, in reasoning by analogy, these compressed globes of stars confound conjecture as to the modes in which the mutual attractions are prevented from causing the universal destruction of their system."

While on the subject of nebulæ, we may mention that a suspicion may perhaps be entertained of some variation in the dark rifts or "canals" discovered by Bond in the Great Nebula of *Andromeda* (Int. Obs. IV., 346). When trying an 8-inch silver-on-glass speculum by Mr. With, 1864, Aug. 31, I have noted "both canals traceable, though very feebly, for a long distance." During the past winter I have been unable to make them out to any certainty with my $9\frac{1}{4}$-inch mirror, which, though its figure is not yet quite complete, is competent to show a black division in γ^2 *Andromedæ;* and I find that the experience has been similar of Mr. Matthews with $10\frac{1}{8}$-inches, and of Mr. With in the use of a $12\frac{1}{8}$-inch mirror of very fine quality. This point certainly deserves attention. It has been suggested by the latter observer, that a rotation of the whole mass would be capable of producing such a result. Were its structure clearly gaseous, change would be less surprising; but Huggins finds a continuous spectrum. It is true, however, that its red end is wanting, and that it is evidently crossed either by bright or dark lines; and these peculiarities, which are common to it, more or less, with 1949 (M. 81), 1950 (M. 82),* and the well-known and brilliant M. 13 (in *Hercules*), have naturally led to a suspicion on the part of that eminent observer, noticed in a previous number, that the apparent stars of some clusters may not be of what we commonly understand as a stellar character—that is, analogous to our

* Int. Obs. VI., 348.

sun, or Sirius, or Wega. Setting aside for the present the inevitable inference from spectrum-analysis, it certainly seems very difficult to ascribe a starry nature to such luminous masses as the *Andromeda* nebula, or its analogue M. 81. It is easy to find cases of resolution, separately, of either a very feeble mist, or a very brilliant and blazing nucleus. But it is not easy to conceive the combination of these two in one object, as in those instances. The stars whose light compose that faint haze, so diffuse that it has no assignable termination, but dies imperceptibly into the dark sky, and can perhaps only be traced in its full extent by a rapid movement of the telescope, must be individually so excessively minute, that such an accumulation of them as would form a bright and vivid nucleus is quite beyond the bounds of probability. No justifiable stretch of imagination could compound the central blaze of those nebulæ out of materials individually less perceptible than the 20th mag. of H., or the 13th of O.Σ. We might indeed have recourse to the supposition that the components all progressively increase in magnitude or luminosity towards the centre; but this, not to mention that it finds little countenance in the known arrangement of stars of various sizes in globular clusters, of which two instances have been given in the present article, is liable to the grave objection of being a special and gratuitous assumption in order to escape from a difficulty. On the other hand, the bare inspection of these nebulæ conveys the strong impression of an uniform material, capable either of great extremes of condensation and rarefaction, or of very varying degrees of luminosity dependent upon unequal temperature, and therefore, in all probability, neither solid nor fluid, unless it might be in a state of extreme division. In short, we can conceive these objects to be an incandescence of either gas, or mist—that is, exceedingly comminuted fluid; or dust—that is, similarly attenuated solid matter; but we can scarcely reconcile their aspect with a stellar composition. Had the spectroscope told us unequivocally that we were wrong, we must have given way to its decision; but we see that its verdict is so far ambiguous as not altogether to shut up the inquiry.

OCCULTATION.

June 15th, B.A.C. 5579, 5 mag. 7h. 7m. to 7h. 41m.

MOON COLOURS.

THE observations on the lunar crater Linné, have established beyond a doubt, firstly, that changes, of an apparently volcanic nature, still occur on the surface of our satellite, and secondly, that alterations take place at a rate sufficiently rapid to hold out the hope that even a brief period of accurate study and comparison may suffice to ascertain and demonstrate their occurrence. It may be that the enormous craters which form such conspicuous features in lunar scenery, belong to a past epoch, when the crust of the moon was in a plastic state, and fresh operations on so grand a scale may not be likely to occur. There would, however, remain the probability of our witnessing alterations which, if less gigantic, might be equally instructive, and for their ascertainment two things are requisite, an exact knowledge of forms and a similar knowledge of colours as they exist at any given time, and as they are modified by local action. The great map of Beer and Mädler, the maps of Lohrmann, etc., have done much for lunar forms, and the British Association map, on which Mr. Birt is engaged, will be of the highest value to future observers, although we must observe that the Moon Committee cannot arrive at a satisfactory result if they leave Mr. Birt to work with a telescope ridiculously small, and which cannot possibly show one quarter, perhaps not one-twentieth, of the minute objects he is expected to lay down with mathematical accuracy. An instrument—say a silvered glass reflector—of at least ten or twelve inches, must be regarded as indispensable, and we hope we may soon hear that he will be provided with a telescope equal to the majority of those which are employed in public and private observatories.

All astronomers perceive the importance of noticing and recording changes of form, but changes in colour may prove nearly as important, and no means of estimating them have yet come into general use. Admiral Smyth's *Sidereal Chromatics* suggested at the time of its publication the propriety of establishing similar standards for the moon, for it is clearly not sufficient to study variations in luminosity without also taking cognizance of modifications of tint or hue.

Few observers can have watched the lunar seas and plains for any length of time without finding evidence that colour changes do occur. The green tint noticed on some spots seems especially to vary, and is often invisible, while modifications appear in the neutral tint blues or ochrey browns. Although we see the moon as an opaque object, its tones of colour are extremely difficult to imitate by opaque pigments.

They are, on fine nights, more like the effect of white light seen through delicate transparent screens of different hues, and could probably be better imitated by transparencies than by drawings on paper, like the star colours of Admiral Smyth, which ought by the way to be imitated in transparent glass.

Mr. Birt has shown us a series of tints on paper which could only be imitated by careful hand-colouring at considerable expense, and he also allowed us to examine an instrument which he terms a "homo-chromoscope," which he brought before the Astronomical Society in 1861, and which is well worth serious consideration. It consists of a number of tints in circular patches painted on a glass slide, and moving in a frame, so that any one can be brought to a central aperture, through which it is illuminated from behind, and observed in front. The light is intended to be reflected by a sheet of white paper suitably placed to catch the rays from a small lamp, and the observer would look with one eye through his telescope, and with the other at the "homo-chromoscope" until he found a tint corresponding with that under his notice upon the moon's surface. The instrument thus devised by Mr. Birt is only in an experimental stage of its existence, but we are anxious to call attention to it, as it could only be brought to a satisfactory state by the co-operation of other observers, and by securing for it, when completed, a sufficient sale.

The first thing to do would be to get a moderate number of good observers, whose eyes are tolerably free from any form of colour-blindness, to agree upon the principal tints. From experiments we have made with a fine refractor of 3 inches, and with a 6½ inch silvered mirror, we find that ordinary observers differ in the amount of yellow they see in the moon, in the quantity of purple they notice, and in their estimation of the greenish tint, which is often invisible to ordinary eyes, and which probably does not always exist. Dull, but *clear* ochrey-yellows, neutral tint blues, sometimes passing into browns, at others into purples and purple greys, all more or less differing from terrestrial colours, and therefore difficult to describe in terms usually applied to them, are what, perhaps, would be generally agreed to exist; but it would be worth while for a "Moon Committee" to request a couple of good colour artists to paint on glass, in transparent tints as near as possible, the tints of Mare Serenitatis and Tranquilitatis, and send copies to ten or twenty observers, and ask for their reports. Many persons find themselves much assisted in estimating star colours or brown tints, by being told how others see them, and this must not be regarded as exciting a prejudice in favour of the tint thus selected, but rather as indicating what delicate peculiarity is to be looked for. If a few

of the most conspicuous lunar tints could be settled by the agreement of a moderate number of good observers, a foundation would be laid for further work.

If the plan of transparent disks should be preferred to that of tints painted on paper, viewed by reflected light, a small lamp should be agreed upon as the source of light. Perhaps the benzoline lamps recently introduced from France would answer, or camphine, or the fluid called photogene might do. Paraffine, as usually burnt, is too yellow, but selecting a fluid, and a mode of burning it which gives an approximately white light, and furnishing the lamp with a bluish tinted glass, would ensure the absence of any disturbing colour; and if appropriate lamps were made cheap, and sold in conformity with a recognized standard, they would be generally used in observatories, and help to secure a uniformity of result.

Our object now is merely to start an idea. If lunar observers think proper to support it, the method of carrying it out will soon be found. Perhaps, instead of reflecting the light of a lamp from white paper, the best way would be to transmit it through the disks of ground glass, recommended by Mr. Slack to microscopists in our last number; but these, if used, must be made all alike.

PROBABLE CONNECTION OF COMETS WITH SHOOTING STARS.

BY W. T. LYNN, B.A., F.R.A.S.,

Of the Royal Observatory, Greenwich.

Professor Adams, at a recent meeting of the Royal Astronomical Society, completely established as a fact, what had been previously suspected by an Italian astronomer, named Schiaparelli, of Milan, that the shower of meteors, which is occasionally and at certain intervals witnessed in the month of November, moves round the sun in an orbit almost identical with that of a comet observed early last year (Comet I., 1866),* which performs a revolution in little more than 33 years. It has also been shown to be highly probable that the August meteors may be identified with a comet seen in 1862, and the April meteors with a comet discovered at New York in the spring of 1861. The conjecture naturally suggests itself that the comets in question compose in fact a kind of congeries, or assemblage of meteors, moving within small distances of each other, which, at a considerable distance, present the appearance of single bodies.

* Discovered by Tempel at Marseilles in 1865, December 19. It was a very faint telescopic comet, and destitute of tail.

From the feeble attraction which was known to hold together the different parts of comets, it appeared not unlikely that they might suffer partial dispersion, and leave behind them a larger or smaller number of particles, which would cause, in the case of periodical, or regularly returning comets, the formation of a ring, more or less complete, along the orbit of the comet. If the comet passes through the plane of the earth's orbit at about the same distance from the sun as the earth itself is, the earth, when it comes to that part of its orbit, must pass through the ring of meteors, causing a display of shooting stars; so that if the ring were quite complete, the earth would pass through it every revolution round the sun, and we should see a meteoric display every year at the same day of the year. But if the ring be only partial, we shall only see a shower of meteors at intervals of several years. The ring therefore produced by the comet of 1862, causing the August meteors, would seem to be more complete than that produced by the comet of 1866, causing the November meteors. Indeed, the latter ring would seem to consist chiefly of but one branch, so to speak, of some length; so that we see a grand display only once in each revolution of the comet or meteors, when the latter are passing through one of the nodes of their orbit; but this occurs sometimes for two or rarely three years in succession.

Now, a very curious idea struck Professor Bruhns, of Leipsic, on considering these recent discoveries. Biela's comet was observed in the year 1846, as we stated in detail in the April number of the INTELLECTUAL OBSERVER, to have separated into two fragments. Could this have been a consequence of its encountering part of one of these meteoric rings, whilst the cohesion of its own separate particles of matter of the same kind was too weak to prevent their being diverted into parts with new centres of attraction by even the slight impulse occasioned by their intermingling with the meteors? The result of his calculation showed that this was really by no means improbable. At the time of the comet's separation, about the end of 1845, he was able to prove that it was, if not actually in, at least very near the orbit of the November meteors.

This remark was followed by an equally interesting one made by Professor d'Arrest, of Copenhagen. Quetelet, director of the Observatory of Brussels, and after him the celebrated Humboldt, had already called attention to a fall of aërolites, which frequently occurred early in the month of December. Now, d'Arrest noticed that this was at the very time that the earth passed through the orbit of Biela's comet.* Hence it appeared probable that that comet had also left particles behind

* *Astronomische Nachrichten*, No. 1633.

it some time anterior to its well-known division in 1845–6; and if this afterwards took place to a still greater extent from the feebleness of coherence of that comet, its almost complete dispersion, and therefore its ceasing to be visible after 1852, would be accounted for.

D'Arrest particularizes the following dates of the December showers:—

1741, Dec. 5.

1798, Dec. 6.—Brandes gives the number of shooting stars observed at Bremen at 2,000.

1830, Dec. 7.—Raillard reports an "extraordinary apparition of shooting stars."—*Comptes Rendus*, vii., p. 177.

1838, Dec. 6.—Flaugergues, at Toulon, saw many meteors "from a point situated at the zenith at nine o'clock in the evening."

1838, Dec. 7.—Edward Herrick, at New-Haven (America), "from a point of the sky situated near the chair of Cassiopeia."

In other years, Colla, Heis, and Quetelet observed many shooting stars on the same nights. According to Flaugergues the radiant-point lies in about R.A. 30°, declination 43° north. Herrick would give a somewhat less right ascension and greater declination; Heis a less right ascension, and less declination; but, at any rate, the December phenomenon differs from those of August and November in this respect, that the meteors appear, at a place in the parallel of central Europe, to proceed from near the zenith.

The corresponding longitude of the earth is about 75°, nearly enough coinciding with the descending node of Biela's comet, the longitude of which, between 1772 and 1832, decreased from 73° to 68°; and it is well known that at this nodal passage the radius vector of the comet is about equal to the mean distance of the earth from the sun.

D'Arrest then calculated the place from which particles moving in the orbit of Biela's comet must appear to radiate at the rencontre with the earth at the nodal passage, and found it to be about R.A. 25°, declination 51° north; so that, to an observer in the parallel of Toulon or New-Haven, they would appear to come from a point in the neighbourhood of the zenith about nine o'clock in the evening of Dec. 5—6. It is therefore possible that they may become visible in the form of the December shooting stars, though d'Arrest says that in his mind the difficulties connected with the assumption are very great.

"Can it be," he asks, "that the celebrated shower of meteors observed by F. Berthou, in Brazil, on the 11th of December, 1836, belongs to those here noticed?" An extraordi-

nary quantity of stones then penetrated into the ground to the depth of several feet, and were scattered over a radius of more than ten leagues.*

Do the great showers of 1798 and 1838 point to a larger display at the end of six periods of 2435 days each, and may another large appearance be expected in 1878?

We will conclude by translating the last paragraph of d'Arrest's interesting paper:—

"Finally, it may be asked whether the intense northern lights, frequently observed coincidently with meteoric showers, may have been the united glimmer of more distant portions of particles dispersed through the orbit of a comet? That some connection exists between meteoric showers and northern lights has been incontestably proved by Quetelet many years ago. If showers of shooting stars and rings of meteors really have any connection with cometary phenomena, the hope is afforded that some explanation may be arrived at concerning the nature of the aurora borealis, and also concerning magnetic storms."

The whole subject of the connection between meteors and comets is exceedingly interesting, and is accordingly engrossing a large share of the attention of astronomers. We seem to be, as it were, on the eve of great discoveries.

ARCHÆOLOGIA.

The Rev. Canon Greenwell has been again pursuing his interesting researches among the tumuli of the Yorkshire wolds. The tumuli which have been the scene of Mr. Greenwell's recent labours are situated on the estates of Mr. B. Foord Bowes, on the mid-wold range, at Weaverthorpe, Cowlam, and Burrow, near Driffield. The one first opened was, in its present condition, a low mound of earth, fifty-six feet in diameter, and two in height. It contained a male skeleton, deposited in the centre, in a circular grave, sunk five feet six inches into the rock, and ten feet in diameter. The body had been laid on its left side, with the head to the north-east, the hands placed in front of the breast, and the knees drawn up to the elbows. With it was found the blade of a bronze dagger, which had had a wooden handle fixed to it by the three bronze rivets, the latter still remaining in their places. There was also a large flint knife, and an implement which is described in the printed account as "a bronze awl or bodkin." Beneath the chin lay five very large polished jet buttons, full an inch and a half in diameter, and one button of baked clay, of similar size and form, but ornamented with four lines radiating from the centre. One of the buttons had

* *Comptes Rendus*, viii., p. 87.

three holes on the back, the others two each. A fine bronze axe was found behind the skeleton; it appeared to have been set in wood. All the bronze articles bore a very fine patina. A deposit of animal bones was found on one side of the tumulus.

The other tumuli, opened on this occasion, formed a group of low, flat barrows, on the top of the Burrow wold, which had become almost obliterated by tillage. Two of them contained the remains of females, who had been buried with their personal ornaments. The one first opened was twenty-two feet in diameter, and two feet in height. In the centre, upon the original surface of the ground, the female skeleton was laid on its left side, with the head towards the north-east, and the hands up to the head. The body had been doubled up. On the right wrist was a beautiful bronze armlet, of the snake-head pattern, with a succession of oval swellings lengthwise. Close to it was a delicate bronze fibula, described as "of the bow shape," and of extremely elegant workmanship, which had originally had a tongue of the same metal, but it had been broken off and replaced by an iron tongue, "fixed in a piece of wood, which passed through the bronze coil of the fibula." The lady had been buried with a necklace of beads, of which fifty-three were of glass, and seventeen of amber. Amber beads, it may be remarked, are usually characteristic of the post-Roman period. The glass beads are described as extremely beautiful, all blue and ornamented, with one exception, with a zigzag pattern in white enamel. The exceptional one was larger and more globular in form than the others, and was ornamented with annulets of white. Scattered about the mound were found a quantity of potsherds, and a few flint chippings. The other tumulus was twenty-four feet in diameter, and only one foot in elevation above the surrounding ground. At the centre, as in the other, on the surface of the ground, lay the skeleton of a female, on its left side, with the head to the north, the hands raised to the face, and the body doubled up. As in the tumulus last described, the lady had borne on her right wrist a bronze armlet of the most beautiful description, "resembling a delicately-formed cog-wheel, with rounded teeth on both sides, the rim between the teeth being ornamented with three grooved lines."

An interesting discovery has been made in France of what is designated as a CELTIC FOUNDRY OF THE BRONZE AGE. It appears that a peasant, while digging in a potato-field in the village of Larnaud, near Lons-le-Saunier, in the department of the Jura, struck against a piece of metal, which he immediately drew to the surface. The spot was examined with care, no doubt in the hope of finding treasure; and at a depth of a little more than a foot, and within a space of somewhat more than a square yard, an immense number of objects in bronze, consisting on the whole of upwards of eighteen hundred pieces, was found matted together. Among them were arms, implements, personal ornaments, and other things of almost every possible description; bars of bronze, residues from melting, two moulds, saws, a file, chisels, and punches, knives, fish-hooks, harpoons, arrow-heads; fibulæ, buckles, buttons, brooches, bracelets, and great varieties of other personal ornaments; chains, apparently

belonging to horses' trappings, umbos of shields, swords and other arms, axes, sickles, hammers, etc., etc. The ignorant peasants who had found these interesting objects immediately carried them to a brazier, who valued them at one franc and forty centimes the kilogramme, and the whole amounted to about sixty-six kilogrammes (a kilogramme being rather more than two pounds three ounces English) ; but the discovery having come to the knowledge of a local antiquary, the whole were saved from the melting-pot, and secured for the local museum. They are described as being all of good workmanship and elegant design. Unfortunately, the published report of the discovery is not accompanied with engravings, without which we can form no very definite opinion of them. It appears to us, however, that it is a mere assumption that they belong to a bronze age, or that this was the site of a manufactory of bronze. They evidently formed the stock-in-trade of some general dealer in objects made of bronze; perhaps an itinerant merchant, who moved from locality to locality, and of course carried no other metal than that in which he dealt, but that must not be taken as evidence that other metals were not in use at the same time. The discovery of a group of objects made all of gold would not be taken as a proof that they belonged to a golden age, in which that was the only metal in use. Similar discoveries of bronze objects, with no intermixture of other metals, are not at all uncommon in our island, though in smaller quantities, and they are usually accompanied with pieces of the residuum of the melting-pot, and of pieces of metal to be used in it, and sometimes with moulds. In each case they represented, no doubt, the stock of some itinerant dealer. It was the common practice to put things of value in a place of security by burying them in the earth, and this is, no doubt, the proper explanation of deposits of this description. It may be satisfactory to some of our friends who are going to the French Exhibition to learn that, after the 27th of the present month of May, the whole of the objects found on this occasion will be on view in Paris, at the house of M. Mazaroz-Ribaillier, sculptor, Boulevard des Filles du Calvaire, No. 20.

We are glad to be able to announce that preparations are making for recommencing EXCAVATIONS AT WROXETER, the site of the Roman *Uriconium*, without delay. It is proposed to begin with a large square room, adjoining the apartment containing the remains of furnaces, which has been called the enameller's shop, and the opening of this room is expected to lead to very interesting results.

T. W.

PROGRESS OF INVENTION.

New Apparatus for Condensing Light.—An apparatus, which has been found to render the light from a given source twelve times as great as in ordinary circumstances, and which, when properly constructed, is believed to be capable of still more important results, has been lately invented at Lille. It consists of a hollow copper vessel, in the form of an ellipsoid of revolution, and having its interior surface silvered. At the extremity of the major axis, which is farthest from the focus in which the source of the light is placed, is an aperture of suitable size, that allows an exit to the rays, after one half of them have been reflected once, and the remainder three times. The extreme rays of the luminous cone thus emitted forms an angle of 45°, but should it be desired to render the rays parallel, they are to be thrown on a prismatic lens. To afford a means of ascertaining the state of the light within the instrument, apertures are formed in it which are fitted with lenses that project images of the light, or a screen arranged for the purpose, but do not sensibly affect the intensity of the light.

Engraving on Steel.—Photography has recently been applied very ingeniously to this purpose. The steel plate, having been covered with a mixture of gelatine and bichromate of potash, or bitumen of Judea, is exposed under a negative obtained in the camera; after which the soluble portions of the coating are washed off. The surface of the steel will then be found more or less uncovered in the lights of the picture. The plate is next gilt in the usual way, by means of the electrotype process; after which, the remainder of the gelatinous coating is to be removed. It is then immersed in dilute acid, which acts on the portions not protected by the gilding, that is on those which are to represent the shades of the picture; the various grades being produced by the presence of a greater or less number of particles of gold, which more or less protect the surface. When the plate is removed from the acid, and washed, a number of copies may be printed from it, and it will be found to produce very excellent pictures.

The Drummond Light.—The opacity of the cylinders of lime used with the Drummond light, is in many cases the source of considerable inconvenience. This is obviated by very simple means, which consists in the use of plates formed of magnesia and chloride of magnesium. Being transparent, they permit the light to be seen at both sides. One of them suffices for a small lamp; for a large one, such, for example, as is used in lighthouses, several are arranged around a centre.

The Glazing of Porcelain.—In ordinary cases a glazing is used for porcelain, which has the convenience of being very easily fused, but the disadvantage of being very readily attacked by acids, and being extremely liable to become full of cracks. Moreover, the presence of the lead, which is one of its constituents, is the source of

considerable danger. A glazing material free from these objections, while at the same time it is easily used, and very economical, is now employed very advantageously Its action depends on the solubility of the alkaline silicates. The article to be glazed is either brushed over with the alkaline solution, or is immersed in it—a larger quantity of it being absorbed when the latter method is adopted, on account of the porosity of the unglazed article. It is then exposed to a temperature which fuses the compounds of silex and the earths. The glazing thus produced has a fine appearance, and is of a most durable kind, being unaffected by caustic liquids or atmospheric changes.

ECONOMIC MODE OF REDUCING COPPER.—It consists in the application of water when the ore is at a high temperature. As soon as the ore has reached a red heat, water is projected upon it in the form of a fine spray, and after the white vapours have escaped, the temperature is raised to that of fusion. With good ore this process is sufficient; with ores of an inferior kind the product of the first fusion, when it has cooled, is broken in pieces, and the process of heating to redness and applying water is repeated. And when fusion is produced, powdered charcoal and lime are added, the whole being thoroughly mixed. The scoria thus formed is removed, and the process is finished by transmission of atmospheric air through the fused mass.

PROTECTION OF ARMOUR PLATES FROM CORROSION.—The fact that even cast iron may be coated with glazing, by spreading on its surface a fusible glass as powder, or, which is better, the materials of which glass is made, and then raising to a proper temperature, has been applied to the coating of iron on the large scale, and it has been proposed to protect armour-plates in this way. The adhesion of the enamel thus produced on the surface of the iron is very firm, since the metal is oxydized, and the oxide combining with some of the constituents of the glass, a compound glass, which adheres strongly to the iron, is formed. If the coating is not too thick, it has but little tendency, even with considerable changes of temperature, to separate from the metallic surface; and it forms a protective coating which, even under very rough usage, and considerable alterations of temperature, has been found, when skilfully produced, to last for years uninjured.

PROCEEDINGS OF LEARNED SOCIETIES.

ROYAL SOCIETY.—*May* 16.

"ON THE OCCLUSION OF HYDROGEN BY METEORIC IRON." By Thomas Graham, Esq., F.R.S. In a paper communicated to the Society in June last, Mr. Graham has shown that metals under certain conditions absorb and retain gases, each metal exerting a selective power. The author now considers that the investigation

of the natural gases of native metals, especially gold and iron, may throw considerable light on their formation. The iron of the well-known Lenarto fall (which, from its purity, appears to be well adapted for the experiment) gave, when distilled in vacuo by means of Sprengel's mercurial exhauster, 2·8 times its volume of gas, of which 85 per cent. was hydrogen, the remainder being nitrogen, and a small amount of carbonic oxide. Messrs. Huggins and Miller have established the presence of hydrogen in the atmosphere of those fixed stars of which Alpha Lyra is the type. It is probable, therefore, that the iron must have occluded its hydrogen from a similar source.

GEOLOGICAL SOCIETY—*May*. 8.

Warington W. Smyth, Esq., M.A., F.R.S., President, in the Chair.

The following communications were read:—

1. "ON NEW SPECIMENS OF EOZOON." By Sir W. E. Logan, F.R.S., F.G.S.—Amongst several additional specimens of *Eozoon* which have been obtained during recent explorations of the Canadian Geological Survey, is one which was found last summer by Mr. G. H. Vennor, in the township of Tudor, county of Hastings, Canada West. It occurred on the surface of a layer, three inches in thickness, of dark-grey micaceous limestone, or calc-schist, near the middle of a great zone of similar rock. This Tudor limestone is comparatively unaltered, and in the specimen obtained from it the skeleton of the fossil, consisting of white carbonate of lime, is imbedded in the limestone without the presence of serpentine or other silicate, a fact which the author regarded as extremely favourable to the view of the organic origin of *Eozoon*. Sir William Logan also described the nature and relations of the rocks of other localities which have recently yielded *Eozoon*, especially Wentworth, Long Lake, and Côte St. Pierre.

2. "NOTES ON FOSSILS RECENTLY OBTAINED FROM THE LAURENTIAN ROCKS OF CANADA, and on objections to the organic nature of *Eozoon*." By J. W. Dawson, LL.D., F.R.S., F.G.S.—The first specimen described in this paper was the one from Tudor referred to in the previous communication. Its examination had enabled Mr. Dawson to state that in it the chambers are more continuous, and wider, in proportion to the thickness of the septa, than in the specimens found elsewhere, and that the canal system is more delicate and indistinct. Without additional specimens the author could not decide whether these differences are of specific value, or depend on age, variability, or state of preservation; he therefore referred the specimen provisionally to *Eozoon Canadense*, regarding it as a young individual, broken from its attachment and imbedded in a sandy calcareous mud. Its discovery afforded him the hope that the comparatively unaltered sediments in which it had been preserved, and which have also yielded worm-burrows, will hereafter still more largely illustrate the Laurentian fauna. After giving short

descriptions of new specimens from Madoc and from Long Lake and Wentworth, Dr. Dawson discussed the objections of Prof. King and Dr. Rowney to the view of the organic nature of *Eozoon*, and stated that those gentlemen had failed to distinguish between the organic and the crystalline forms, as was especially illustrated by their regarding the veins of crysotile as identical with the tubulated cell-wall of *Eozoon*.

ROYAL MICROSCOPICAL SOCIETY.—*May* 8.

James Glaisher, Esq., F.R.S., President, in the Chair.

The Rev. J. B. Reade, F.R.S., read a paper on a remarkable dichroic liquid obtained from a pond. The water was tinged with a colouring matter which appeared red by reflected, and violet by transmitted light. The peculiarity seemed to result from the action of growing organisms upon soluble albumen, and Mr. Reade exhibited a similar fluid artificially formed. Mr. Browning explained the character of its spectrum, which was very remarkable, the principal characteristics being two cloudy absorption bands, one in the orange and another in the green.

Two new lamps were described by Ellis G. Lobb, Esq., one a small camphine lamp, patented by Young, and the other a cheap and convenient travelling lamp, devised by Mr. Piper; both were considered very handy. Dr. Lionel Beule read a very interesting paper on "Nutrition considered from a Microscopical Point of View," in which he developed the hypothesis that all matter capable of growth by nutrition originates by descent from similar matter. He also showed that the serum of the blood, and not the globules, was its nutritive portion.

NOTES AND MEMORANDA.

The Stability of Gun Cotton.—*Proc. Roy. Soc.*, No. 92, contains a paper on this subject by Mr. F. A. Abel, F.R.S., in which he states that if gun-cotton is prepared in strict accordance with Von Lenk's system, it will resist to a remarkable degree the destructive effects of prolonged exposure to temperatures even approaching 100° C. Ordinary gun-cotton contains small quantities of nitrogenous impurities, which decompose and give rise to a free acid when exposed to heat. One per cent. of sodic carbonate neutralizes this acid, and is sufficient to prevent serious change. Water acts as a most perfect protection to gun-cotton (except when it is exposed for long periods to sunlight), even under extremely severe conditions of exposure to heat. It is not necessary that the gun-cotton should be wet, a slight dampness being sufficient.

Mimetic Butterflies.—Mr. Wallace has been exhibiting at 76½, Westbourne Grove, a very interesting series of objects from the Indian archipelago. Amongst them is a case with a label affixed, stating that it contains fourteen butterflies. The visitor is completely puzzled, seeing only twigs with dead leaves upon them. On closer examination, it appears that each seeming dead leaf is a butterfly, with wings folded, and perched on the twig so as exactly to resemble the insertion of a leaf. To make the imitation more complete, the undersides of the wings, which alone are visible, are speckled with dull colours resembling patches of microscopic fungi.

Separating Power of Telescopes.—Mr. Dawes has a paper in *Monthly Notices* which forms the introduction to his "Catalogue of Micrometrical Measurements of Double Stars," in which he states that a telescope with one-inch aperture will just separate two sixth magnitude stars, if their central distance is 4″.56, and the atmosphere favourable. Hence the separating power of any given aperture, a, will be expressed by the position $\frac{4''.56}{a}$. According to this formula a three-inch aperture should divide stars 1″.52 apart; a four-inch 1″.14; a five-inch, 0″.91; a six-inch, 0″.76; and a twelve-inch 0″.380. These calculations refer to refractors; the *finest* reflectors, like Mr. With's mirrors, probably have some advantage over refractors.

Action of Trees on Rainfall.—M. Becquerel states (*Comptes Rendus*), that in wooded localities the maximum rainfall occurs in summer, and in non-wooded localities in autumn.

Transparency of Red-hot Iron.—In a communication of Father Secchi to the French Academy, it is stated that a tube of forged iron was being constructed for a meteorograph, and he was afraid that the new tube might not preserve a vacuum as accurately as one previously made. It was accordingly made cherry red, almost white hot, and viewed in a dark place, when a slight flaw was seen inside it. Father Secchi observes, "That red-hot iron is transparent to a depth of half a centimetre at least.

Poisons of Spreading Diseases.—Dr. Richardson has published in pamphlet form* his lecture delivered before the Sewage Congress, in which he refers to an observation of Dr. Salisbury during the American War, that a number of men who slept on straw containing a certain mould or fungus, were seized with measles, and he found that by inoculating himself and his family with the fungus, measles was produced. Dr. Kennedy, of Dublin, is stated by Dr. Richardson to have made similar observations. Dr. Richardson considers iodine as the best chemical agent for destroying organic poisons. Iodine placed in a box covered with muslin will diffuse itself at a temperature of 70°, at the rate of a drachm in twenty-four hours. Heat and sunlight favour the destruction of the poisons.

Aerial Navigation.—At a meeting of the French Academy, 29 April, M. Babinet spoke favourably of a machine invented by M. de Louvrié. The motive power consisting of hydrocarbon vapour mixed with air, and exploded in a cylinder having one circular opening. Twenty or thirty explosions per minute were said to suffice. MM. Babinet, Piobert, and Delaunay were requested to examine the apparatus and report upon it. *Cosmos* gives some further particulars of remarks made by M. Babinet, and not printed in *Comptes Rendus*, from which it appears that the apparatus is formed of an inclined plane, making a small angle with the horizon, and moved horizontally by the reaction of a series of explosions producing currents in the opposite direction. M. Louvrié has only made the machine on a small scale, and M. Babinet wished the Academy to have a larger one constructed. M. Flammarion (in *Cosmos*), describing the plan, says that a kite, ten metres, each side formed of wire gauze, with the interstices filled with gutta percha, is to be solidly fixed to a car of thin copper, able to hold a man lying down, and to contain a supply of the combustible liquid at its extremities. The inclination of the plane of suspension is to be moved as required by wire ropes, worked by an endless screw. At each end of the apparatus, cylinders of steel are to be filled with a mixture of air and petroleum vapour, by means of a pump, and exploded alternately by electric spark. From this description we should not like to join M. Babinet in predicting the success of the scheme. It seems sure to fail.

* Churchill and Sons.

AUGUSTUS.

Co[illegible] Blacas Collection, lately added to the Bri[illegible] Museum.

THE INTELLECTUAL OBSERVER.

JULY, 1867.

CAMEO OF THE EMPEROR AUGUSTUS IN THE BLACAS COLLECTION.

BY THOMAS WRIGHT, M.A., F.S.A.

(With a Coloured Plate.)

PERHAPS the most important of the additions made to the antiquarian department of the British Museum of late years was by the purchase entire, for the sum of sixty thousand pounds, of one of the best known collections in France, the antiquities of the Duc de Blacas. The French antiquaries, who regret greatly that they let this interesting collection slip out of their hands, praise our own negotiators for the skill and energy they displayed throughout the whole affair. The duc, who, since the overthrow of the elder branch of the Bourbons in France, had withdrawn from anything like political activity, devoted his time and wealth to his museum, to which most of the collections sold during his time contributed more or less largely. He purchased the whole Strozzi collection, from Rome, with the exception of one beautiful gem, representing the young Hercules (*Hercules juvenis*), engraved on a sapphire, and bearing the name of the engraver in Greek letters, ΓΝΑΙΟϹ (*Cneius*). While the collection was still in the possession of Strozzi, this fine work of art was stolen, and a copy in glass left in its place. Years after, when the collection had passed to the Duc de Blacas, who imagined that he possessed the original gem, he was [illegible] at [illegible] it brought to him [illegible] discovering the [illegible] he succeeded in obtaining possession of it [illegible]. This [illegible] is now with the rest of the collection in the British Museum. His taste as a collector appears to have run chiefly upon three classes of [illegible] Greek and Etruscan vases, engraved and sculptured gems, and [illegible] personal ornaments in gold. The first of these three classes, that of the vases, has been made better known to the public than the others through

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the works of Panofka, De Witte, and others; and some of the finest of the gems in the Blacas collection having been derived from the older and better known Strozzi collection, have been spoken of in different works on this branch of ancient art, but otherwise the contents of the museum of which we are speaking are not very generally known. It was from the Strozzi collection that the duc obtained the noble cameo of Augustus, represented in our accompanying plate.

So much has been written on the history of precious stones and of the lapidary's art, that it is now hardly required, in treating of a subject like this, to go at any length over ground which has been so well trodden before. The ancients themselves had abundance of wonderful stories of the immense values set upon particular precious stones, and of the singular parts they had sometimes played in history. Pliny the Elder, in his chapters on this subject (*Hist. Nat.*, lib. xxxvii.), tells us that it was the common belief that the first individual who wore a ring with a stone in it was Prometheus, who had been condemned by Jupiter to carry on his finger, as a memorial of his offences, a bit of the rock of Caucasus set in a ring of iron; and this, he tells us, was, according to the tradition, "the first ring and the first jewel known." But Pliny adds that, in this case, he disbelieved the tradition, and that his opinion was that this ring of Prometheus was only that of the chain by which he was bound to the rock. The same writer tells us next of the celebrated jewel of Polycrates, the tyrant of Samos, upon which so much value was set that he imagined that the voluntary loss of it would be a sufficient expiation to the inconstancy of Fortune to avert her wrath, and he went out to sea, and threw the ring containing the jewel into the waves. But the fickle goddess refused to accept it; a large sea-fish, served at the king's table, was found, when carved, to contain in its belly the fatal jewel, which was restored to the king; and the latter, in the sequel, ended his life miserably. Pliny tells us that this precious stone was a sardonyx, which was still in his time preserved at Rome, where it had been given as part of the ornamentation of a horn to the Temple of Concord by the Emperor Augustus, and he says that it was there considered as much inferior to many other jewels then collected in the Roman capital. It was reported, a few years ago, that the ring of Polycrates had been found in a vineyard near Rome, by a vine-dresser of Albano; but as it was described as a very fine intaglio, with the name of the artist, it is probable that the whole story was a fiction, or the ring a forgery.

The object of the first people who made use of precious stones, was of course to display the stones themselves, on account of their beauty and the great value set upon them. Pliny,

launching out into admiration on this subject, says that a precious stone is an object "in which the majestic might of nature presents itself to us, contracted within a very limited space, though, in the opinion of many, nowhere displayed in a more admirable form." Many people, he says, looked upon it as no less than sacrilege to engrave them, even for signets, although he considers that the especial purpose for which they were created. In another part of his great work (*Hist. Nat.*, lib. xxxiii. c. 4), Pliny recurs to the ring of Prometheus, mentioned above, and to rings of iron and of gold. As might be expected, some of these primeval rings became celebrated for qualities which were more than natural. Midas, according to our writer—others say Gyges—had a ring which, upon the collet being turned inwards, caused the wearer to become invisible. The only rings known among the early Romans, were of iron, and even they only came into use at rather a late period. At the very close of the republic, a gold ring was only made use of on public and ceremonious occasions of great importance. The *annulus pronubus*, which was sent as a present to a betrothed woman, as a sign of her engagement, was only of iron. Pliny believed that the use of rings had not existed even in Greece at the time of the Trojan war, and he tells us that the first date in Roman history at which he could trace any general use of them was in A.U.C. 449, in the time of Cneius Flavius, the son of Annius. Yet, as he adds, after this date they must have come into use very rapidly, for, in the second Punic war, they were so abundant that Hannibal was able to send from Italy to Carthage three modii of them. The next advance in luxury was the practice of inserting or setting a precious stone in the gold of the ring, and it was not till a still later period that the use of signet rings was adopted, which implied the engraving of a device, of some kind or other, on the stone of the ring. Pliny tells us distinctly that the stone of the ring of Polycrates, or at least the one shown for it at Rome in his time, presented no traces of engraving.

The first engraved gem he mentions belonged to Pyrrhus, king of Epirus, the great enemy of the Romans. This was in the first half of the third century before Christ, and the history of precious stones was still involved in so much mystery, that King Pyrrhus was believed to have in his possession an agate (*achates*) on which were figured the nine muses, with Apollo holding a lyre, the work not of the engraver, but of nature herself, the veins of the stone being so arranged naturally, that each of the muses had her own peculiar attribute. At a later period, notions like this prevailed extensively, and in the more ignorant periods of the

middle ages, people believed that the ancient intaglios and cameos, which were often found in digging the ground on ancient sites, were natural objects, and that engraving on them was a mere natural indication of the special power or quality each possessed. Some of the mediæval writers believed that the *fidus Achates* of Roman fable was nothing but a precious *agate*, on which depended the fortunes of Æneas.

We know nothing of the first beginnings of the art of engraving upon precious stones, but it appears to have come from the East. Pliny, who is our chief authority on these matters, mentions an edict of Alexander the Great, forbidding the engraving of his portrait on a smaragdus (supposed to be the emerald) by any other professor of the art but Pyrgoteles. We seem from this justified in supposing that, in the age of Alexander, the art of engraving on gems was extensively practised in Greece. Less than a century before Christ, Mithridates, the celebrated king of Pontus, possessed a dactyliotheca, or museum of signet rings. With Augustus and the earlier Roman emperors, the possession of these dactyliothecæ became a great subject of pride, and the Romans displayed a sort of wild extravagance in their taste for possessing cameos and intaglios, and in the immense sums they gave for them. The first who formed a dactyliotheca at Rome was Scaurus, the stepson of the dictator Sylla, but all we know of it is the statement of Pliny, that it was much inferior to that of Mithridates, which latter was transferred to Rome by Pompey the Great, the conqueror of Mithridates, and presented by him to the capitol.

The contents of the dactyliothecæ appears to have been little appreciated by the Barbarians, and, after the fall of the empire of the West, the taste for this branch of art was carried to Byzantium, whence it returned to Western Europe in the fifteenth century. Yet the people of the middle ages, with that mysteriously superstitious regard for them already noticed, sought eagerly to be possessed of them. It is very common to find a great baron or knight, or an ecclesiastic, sealing his charter or other document with a seal in which an ancient intaglio is set instead of an ordinary mediæval seal. Perhaps he thought that, being an object of comparative rarity, the possession of it was something to be proud of; but it is probable also, that he looked upon it as possessing some superior power which gave him protection or security. In this belief, catalogues of intaglios and cameos, with lists of their several qualities, or virtues, were published, and are sometimes found in mediæval manuscripts. But the ecclesiastics made the greatest profit of them in this point of view, for they collected them in their churches and monasteries, gave out that they were en-

dowed severally with the power of curing different diseases by their mere application, and demanded good fees for applying them. We might quote many such curative properties of individual gems, some of which are undignified enough. A fine cameo possessed by the monks of St. Alban's, and probably derived from the ruins of Verulamium, was believed to give ease to women in the pains of childbirth, and was lent on such occasions—no doubt for a consideration. Another very handsome cameo, described by one of the modern writers on this subject, was looked upon with regard as a preservative against rats! Among a great number of such objects formerly preserved in the treasury of the Cathedral of St. Paul's in London, one, which bore a figure of Andromeda, had the power of raising love between man and woman; one with the figure of a hare was a protective against the devil; a dog and a lion on the same stone preserved against dropsy; the figure of Orion gave to one of these stones the quality of securing victory in war; in another the figure of a syren, sculptured in a jacynth, rendered the bearer invisible.

It was in a great measure out of these mediæval collections of gems, ecclesiastical or lay, the result of mere accidental finds, that our modern collections have been formed, with the addition of others found in antiquarian excavations of a later date, and they are thus, more or less, of a very miscellaneous character. The dactyliotheca of the Roman age, if collected by a man of taste, would contain nothing but stones of the highest degree of art, and even if he erred in judgment himself, he could find an adviser who would assist him; he did not collect his specimens by chance, glad to get all that came to hand, but sought them from the best sources, so that he had probably nothing but what was good. It is different with the modern collector. The cameos and intaglios which are brought to light by ordinary antiquarian excavations are, for the most part, of a very low degree of merit, such as no doubt were possessed by people of the commoner classes. The modern collector has little but these to collect from, and not in such abundance but that he is glad to get all he can, or at best to pick out here and there any one which seems better than the others, and wait for a rare chance of obtaining something of a very superior character. Such is the general character of the contents of most modern cabinets, and especially of such as have been made by private collectors; and such, no doubt, is the cabinet of intaglios and cameos of the Duc de Blacas. It contains a certain number of very fine works of art, among a large quantity of specimens of very ordinary merit. This is especially the case among the intaglios, which may perhaps be said to be the case generally. The stones necessary for the

cameos were rarer than the others, and were probably seldom given to the artists of inferior merit who employed themselves on intaglios, and the two processes differed considerably in the manner of carrying them into execution. In modern excavations on ancient sites, an intaglio is often found, but a cameo very rarely. Even now we do not know where the Romans obtained the large sardonyxes on which they engraved the fine cameos which are preserved.

The sardonyx on which the fine head of Augustus in the Blacas collection is engraved forms an oval, five inches and a quarter in length, by three inches and three quarters in breadth, and is of very good quality. The ground, or layer, of the stone out of which the head rises is of a fine russet colour, which throws the engraving into very delicate, though rather low relief. A head of Medusa appears to form the centre of the shield which covers the breast. Augustus has a band, or fillet, round his head, the sign of his imperial dignity, on which are set four precious stones, an emerald on the left, and, following it in their order towards the right, a sapphire, a topaz, and a ruby, and round the figure in the middle are arranged four very small diamonds. In the collection of the Imperial Library at Paris, there are several cameos as large, and perhaps a little larger, than the Augustus of the Blacas collection, but there is hardly one of them that equals it, and certainly not one that excels it as a work of art. The expression of the countenance is brought out with great delicacy and refinement, and the artist has displayed the greatest skill in taking advantage of the colours and shades offered him by the stone. Little appears to be known of the history of this remarkable work of art, except that it was formerly in the Strozzi collection.

The age of Augustus is said to have been that at which the art of engraving precious stones was carried to the highest degree of excellence among the Romans, and we need not therefore be surprised if we find so many of them representing the features of that emperor. Pliny (xxxvii. 4) celebrates the merits of a portrait of Augustus by an engraver named Dioscorides, which was used as the signet of the emperors who succeeded him. One of the finest cameos known is a tricoloured sardonyx, about a foot high, representing, in twenty-two figures, the apotheosis of the Emperor Augustus, and which was therefore probably engraved soon after his death. It was brought from Constantinople in the reign of St. Louis, and being, in the ignorance of that time, supposed to represent the triumph of Joseph over Pharaoh, it was considered to regard the church more than the laity, and was placed by that monarch among the treasures of the Sainte Chapelle in Paris.

It is now preserved in the Bibliothèque Impériale. In the same case with the large cameo of Augustus in the Blacas collection there is a small one, of the same emperor, also on sardonyx, which came likewise from the Strozzi cabinet.

The choicest examples of the Blacas collection are arranged in two cases, at the two ends of a box or frame, one with the large cameo of Augustus in the centre, looking towards the entrance-door, the other in the opposite direction. The first contains forty intaglios and cameos, and among the latter, besides the two already described, a cameo on sardonyx, representing a portrait of Tiberius, also from the Strozzi collection, which strikes us by its wonderful relief, but it has suffered much from rubbing. Among the intaglios in this case are a portrait of Julius Cæsar engraved in jacynth, the features of which are wonderfully sharp and delicate; a Silenus, on cornelian, with full face, remarkably fine; another Silenus, side face, on amethyst, which is also finely executed, and has the name of the engraver inscribed in Greek letters, Hyllus; and a Mænad, whose wild and drunken fury, and the voluptuous fleshiness of her bosom, are represented with extraordinary effect. The other select case contains forty-two examples. It also has its large cameo, well executed, on a sardonyx about five inches high, representing the Empress Messalina. The portrait of Juba II. is represented in a delicate little cameo on sardonyx. A head of Livia, on cornelian, is also worthy of our notice, because the head is in intaglio, surrounded by a border in cameo. This also came from the Strozzi collection. Among the intaglios in this case, we may call attention to a female head in cornelian, with a sweet little face; a very characteristic portrait of Vespasian, in cornelian; and a small head of Horace, in topaz, of considerable merit. There is also in this case what is called an amulet, in cornelian, formed in the shape of the petal of a flower (perhaps intended for a rose), with two small Cupids, very prettily executed in intaglio.

The rest of the intaglios of the Blacas collection, with two or three cameos, are placed in three large cases, upon tables, on the other side of the room, and are mostly of inferior work. Many of them have suffered from rubbing and ill-usage. They amount in all to 384. We may, in passing over them, point out to notice No. 20, a neat little cameo of a horse, of tolerably good work, and No. 245, a sardonyx remarkable for its neat border of astragals.

In the course of collecting, the Duc de Blacas embraced a taste for acquiring a class of monuments which were then comparatively little thought of, those of the earlier ages of Mahometanism, which are intimately connected with the present article

by the circumstance that among them the intaglios, or engraved stones, hold a very prominent place. The duc was one of the earlier friends of the late accomplished and lamented professor of Arabic in Paris, M. Reimaud, who, at one time, might almost be looked on as the keeper of his Mussulman antiquities, and who, in 1828, published, in two octavo volumes, a very learned description of them, under the title of *Monumens Arabes, Persans, et Turcs, du Cabinet de la Duc de Blacas et d'Rures Cabinets.* The choice Mahometan intaglios of the Blacas collection are engraved and described in this work. We know that, at an early period, the intaglios had been imitated by many of the eastern religious sects in the form of cabalistic seals, some of which are found in the Blacas collection, which are known by the name of Abraxas. The Mahometans also, no doubt, borrowed the practice of engraving on precious stones from the Romans and Greeks, and they used them for the same purposes, as signets and seals, but they presented one special point of difference with both the seals of the Greeks and Romans, and with the Abraxas, a difference which of course belonged to their religious ideas. They are distinguished by the total absence of all figures, only letters being engraved upon them. These inscriptions are generally of a more or less religious character, consisting usually of short invocations or reflections, pious, moral, or superstitious. A few of the older ones are of a talismanic, astrologic, or cabalistic character.

CHEMICAL AIDS TO ART.—No. II.

BY PROFESSOR CHURCH, M.A.

Of the Royal Agricultural College.

I PURPOSE describing, on the present occasion, several methods for the permanent artistic decoration of wall surfaces. In our climate the processes of distemper and fresco painting have some serious drawbacks. The size used with the colours in distemper is liable to perish, while the dust and soot which accumulate on the decorated surfaces cannot be removed by any cleaning process, save, to a certain extent, by washes of spirits of wine. Besides the mechanical difficulties of fresco painting, which often hinder so seriously the artistic perfection of the works executed by this method, it is by no means certain that the painting will be permanent, even when every care has been taken. The experience of Italy in this matter must not be accepted as a sure guide for our own artists. The enormous size of our great cities, and the vast amount of coal and gas consumed in them, render their atmospheric conditions very unfavourable for the permanence of works in fresco. As such artistic works will probably for some time to come be executed only in large towns, it is greatly to be desired that some process of painting at once easy and permanent, could be devised. Many attempts have been made in this direction, and the success already attained has been, no doubt, considerable. I shall describe the chief features of several more or less novel processes of wall painting, pointing out here and there their advantages and disadvantages, and also offering, where practicable, some hints for their alteration and improvement.

As a new method of painting, intimately depending on recently discovered chemical facts, first and foremost stands the process called water-glass fresco, or stereochromy. The plastered wall is partially saturated with a weak solution of the soluble silicate of potash (made by boiling calcined flints, which have been *étonné* in cold water, with caustic potash under pressure); the wall is allowed to dry, and then the painting is commenced. Ordinary fresco colours are employed, but the only white to be used is zinc white. Some colours, those which are affected by alkalies, cannot, however, be used with success. Among these, the chrome yellows, the lakes, several of the madder colours, and all the copper and arsenical greens, are inadmissible. All colours, on the other hand, which are not acted upon by alkalies, such as vermilion, smalt and chrome green, with the yellows and reds made from iron oxides

and ivory black, with burnt siena, burnt umber, and similar preparations, may all be fixed to the prepared wall surface without injury. A great difficulty will be experienced at first in laying on the colours, since no medium but water or lime-water is admissible. By keeping the wall constantly wet with lime-water, or baryta-water, this difficulty may be partially removed. All the water used in the process, from the preparation or priming of the walls to the final fixing of the coloured surface, must be pure distilled water. This final fixing of the painting is accomplished as follows:—A weak solution of pure silicate of potash is prepared (several applications of a weak solution are much more effective than two or three applications of a strong liquor) by mixing the ordinary liquid silicate of potash of commerce with thrice its bulk of water. It is of course impossible to lay on the fixing liquor with a brush, which would infallibly cause the removal of much of the colour. A complicated spray-producer, or syringe of peculiar construction, was invented for the purpose, and has been used extensively. But I have found that a very cheap and effective instrument may be made by attaching, with an India-rubber tube, a small pair of hand bellows to the little contrivance familiarly known as La Bouffée, or L'Odorateur. The apparatus should be examined carefully to see that no drop of liquid—nothing but spray—is blown against the painting. The syringing is renewed at intervals of a few days, till—when the painting is dry—a wet cloth removes no particle of colour. Over-silication will produce a glaze which renders the surface spotty, and unpleasant in appearace. No re-touching, after fixing, is permissible, unless the old colour be first removed by scraping. Any soluble efflorescence which may make its appearance on the wall in the course of a few months, may be removed by a thorough washing of the surface with hot distilled water; indeed this treatment is in all cases desirable. Another kind of efflorescence also occasionally makes its appearance. This latter substance is, unfortunately, insoluble in water and all usual solvents, and can scarcely be removed even by mechanical means. It consists chiefly of an insoluble silicate, and seems to arise from an insufficiency of alkali in the water-glass used. For it is a great mistake to suppose that the excess of potash in the original silicate can be safely removed, as some chemists have recommended, by the addition to it of gelatinous silica, or of a diluted solution of silica. Indeed, on the other hand, the introduction of a small quantity of caustic potash to the diluted medium is often desirable. When this second kind of efflorescence has once appeared, the unpleasant bloom which it imparts to the painting may be partially obviated by syringing

the surface with pale copal varnish, diluted with twice or thrice its own bulk of spirits of turpentine.

Since Professor J. Fuchs, of Munich, published his important paper on Water Glass (in 1825), this process, in which it is artistically employed, has developed greatly in the hands of Kaulbach, and other German artists, at Berlin and Munich, and also in this country likewise. Maclise, for instance, has worked most successfully with it in the Royal Gallery of the House of Lords, but it remains to be proved that the works of these artists are safe against all the evils of the process. The silicious bloom has, in several instances, appeared upon the works of those who are thoroughly well versed in all the minute details of the process. It is probable that the method will have to be modified greatly, so as to get rid of its technical difficulties and its chemical defects before it can command the general confidence of artists. In some of the other processes which we will now describe, there probably exist the germs of real improvements in these particulars. Professor Kuhlmann, of Lille, suggested, some years ago, the combined use of silicate of potash and aluminate of potash for the fixation of colours, as well as for the hardening of stone. One great objection to this process, in which the colours are mixed with a solution containing both silicate and aluminate of potash, is the excessive alkalinity of the preparation. The union of these two caustic potash compounds yields a solid glassy substance, but this compound is far from being analogous, as has been alleged, to felspar in its constitution, for it contains many times as much alkali as that mineral. Nor is it wholly unchangeable, for it spontaneously undergoes a process of disintegration, although this does not occur generally for some time. A wall decorated by this process never dries, and retains its alkalinity for years, as may be easily shown by placing a piece of moist yellow turmeric paper upon the painted surface; the alkali will change the yellow of the turmeric paper into brown.

But if we leave the soluble silicates altogether, we shall find that there are other chemical compounds which can effect the same objects. If a ground for painting be prepared with lime, whitening, and sand, and the colours be mixed with a five per cent. solution of soluble phosphate of lime instead of with water, they will readily adhere, while no soluble salts whatever will be formed in the wall, insoluble bone-phosphate only being produced. Good proportions for the plaster are three parts of burnt lime and two of whitening, both ground together into a fine powder; five parts of pure sand, or of marble grit, are then mixed with this powder, and the whole made into a paste with baryta-water. This material is spread

in a thin layer upon the wall, and when dry affords a most retentive ground, which should be moistened with distilled water before it is painted upon. Nearly all the good vegetable colours, and many other pigments which are inadmissible in the two former methods of wall painting, may be freely used in this third method. Any portion of the picture not fixed when dry should be syringed with the soluble phosphate liquor till the desired effect is produced. Alternate syringings with phosphate liquor and baryta-water are very effective occasionally, but they lighten the shade of colour to which they are applied considerably. This process admits of much further elaboration, and, probably, of great and beneficial improvements. The soluble phosphate solution may be made by boiling one ounce of the best superphosphate of lime in three ounces of water: when the mixture is cold, the clear liquor is poured off for use.

A fourth process will lastly demand a brief notice; it is not essentially a new method, and can scarcely claim to be dependent upon a chemical action, similar to those which take place in the methods already described. It may be termed the copal process. Mr. Gambier Parry, the well-known amateur artist, has developed this method, and we shall follow his directions in describing how it is to be carried out. A dry wall is necessary. Ordinary plaster (not whitening), free from salt, etc., is the surface on which the painting is to be executed. The colours are not mixed with oil, but with a medium thus made: take of white wax, four ounces by weight; elemi resin, one ounce by weight. These substances are to be melted together, and strained hot through muslin; they are then to be incorporated, by careful heating, with oil of spike lavender, six ounces by measure; fine copal varnish, twenty-two ounces by measure. When the mixture is uniform, it is to be allowed to cool, and is then ready for use. The colours should be ground with it, and be preserved in covered pots. The surface is prepared by saturating it with two or three washes of the above medium, diluted with half its bulk of spirits of turpentine. The colours may be thinned, and the brushes cleaned with oil of spike or of turpentine; but all kinds of fixed oil must be excluded. This process admits of the highest technical excellence, and, although the painted surface does not acquire a rocky hardness, like that of the stereochromic and similar methods, it is certainly far less liable to change, and has a more complete hold of the wall than any ordinary system of applying colours. Very good examples of this method are to be seen in Mr. Parry's church, at Highnam, near Gloucester, and more especially in one of the southern chapels of Gloucester Cathedral.

The method, slightly modified, is also applicable—where most processes fail—to the retention and restoration of ancient ecclesiastical frescoes. In using the process, both for original work and for restorations, I confess I prefer to adopt a somewhat different plan for preparing the medium. I find the following directions to yield an excellent product, and to be very easy to carry out:—Dissolve three-quarters of an ounce of elemi in six ounces of oil of spike, in a flask, by the aid of heat: the fragments of bark in the elemi will sink to the bottom of the vessel; melt three ounces of white wax and one ounce of pure white paraffine in another flask; mix the two liquids together, and allow the impurities to settle. Put twenty-two liquid ounces of fine pale copal varnish—picture copal—in a tin can; keep the can plunged in boiling water for half an hour or more; pour the elemi and wax mixture (also hot), into the can, stir it, and keep warm some time longer. This preparation may be used, diluted, etc., exactly as previously directed.

THE PHILOSOPHY OF BIRDS' NESTS.

BY ALFRED R. WALLACE, F.Z.S., ETC.

Birds, we are told, build their nests by *instinct*, while man constructs his dwelling by the exercise of *reason*. Birds never change, but continue to build for ever on the self-same plan; man alters and improves his houses continually. Reason advances; instinct is stationary. This doctrine is so very general that it may almost be said to be universally adopted. Men who agree on nothing else, accept this as a good explanation of the facts. Philosophers and poets, metaphysicians and divines, naturalists and the general public, not only agree in believing this to be probable, but even adopt it as a sort of axiom that is so self-evident as to need no proof, and use it as the very foundation of their speculations on instinct and reason. A belief so general, one would think, must rest on indisputable facts, and be a logical deduction from them. Yet I have come to the conclusion that not only is it very doubtful, but absolutely erroneous; that it not only deviates widely from the truth, but is in almost every particular exactly opposed to it. I believe, in short, that birds do *not* build their nests by instinct; that man does *not* construct his dwelling by reason; that birds do change and improve when affected by the same causes that make men do so; and that mankind neither alter nor improve when they exist under conditions similar to those which are almost universal among birds.

Let us first consider the theory of reason, as alone determining the domestic architecture of the human race. Man, as a reasonable animal, it is said, continually alters and improves his dwelling. This I entirely deny. As a rule, he neither alters nor improves, any more than the birds do. What have the houses of most savage tribes improved from, each as invariable as the nest of a species of bird? The tents of the Arab are the same now as they were two or three thousand years ago, and the mud villages of Egypt can scarcely have improved since the time of the Pharaohs. The palm-leaf huts and hovels of the various tribes of South America and the Malay Archipelago, what have they improved from since those regions were first inhabited? The Patagonian's rude shelter of leaves, the hollowed bank of the South African Earthmen, we cannot even conceive to have been ever inferior to what they now are. Even nearer home, the Irish turf cabin and the Highland stone shelty can hardly have advanced much during the last two thousand years. Now, no one imputes this stationary condition of domestic architecture among these savage tribes to instinct, but to simple imitation from one generation to another, and the absence of any sufficiently powerful stimulus to change or improvement. No one imagines that if an infant Arab could be transferred to Patagonia or to the Highlands, it would, when it grew up, astonish its foster-parents by constructing a tent of skins. On the other hand, it is quite clear that physical conditions, combined with the degree of civilization arrived at, almost necessitate certain types of structure. The turf, or stones, or snow—the palm-leaves, bamboo, or branches, which are the materials of houses in various countries, are used because nothing else is so readily to be obtained. The Egyptian peasant has none of these, nor even wood. What, then, can he use but mud? In tropical forest countries, the bamboo and the broad palm-leaves are the natural material for houses, and the form and mode of structure will be decided in part by the nature of the country, whether hot or cool, whether swampy or dry, whether rocky or plain, whether frequented by wild beasts, or whether subject to the attacks of enemies. When once a particular mode of building has been adopted, and has become confirmed by habit and by hereditary custom, it will be long retained, even when its utility has been lost through changed conditions, or through migration into a very different region. As a general rule, throughout the whole continent of America, native houses are built directly upon the ground—strength and security being given by thickening the low walls and the roof. In almost the whole of the Malay Islands, on the contrary, the houses are raised on posts, often to a great height, with an

open bamboo floor; and the whole structure is exceedingly slight and thin. Now, what can be the reason of this remarkable difference between countries many parts of which are strikingly similar in physical conditions, natural productions, and the state of civilization of their inhabitants? We appear to have some clue to it in the supposed origin and migrations of their respective populations. The indigenes of tropical America are believed to have immigrated from the north—from a country where the winters are severe, and raised houses with open floors would be hardly habitable. They moved southwards by land along the mountain ranges and uplands, and in an altered climate continued the mode of construction of their forefathers, modified only by the new materials they met with. By minute observations of the Indians of the Amazon Valley, Mr. Bates arrived at the conclusion that they were comparatively recent immigrants from a colder climate. He says:—"No one could live long among the Indians of the Upper Amazon without being struck with their constitutional dislike to the heat. . . . Their skin is hot to the touch, and they perspire little. . . . They are restless and discontented in hot, dry weather, but cheerful on cool days, when the rain is pouring down their naked backs." And, after giving many other details, he concludes, "How different all this is with the Negro, the true child of tropical climes! The impression gradually forced itself on my mind that the Red Indian lives as an immigrant or stranger in these hot regions, and that his constitution was not originally adapted, and has not since become perfectly adapted, to the climate."

The Malay races, on the other hand, are no doubt very ancient inhabitants of the hottest regions, and are particularly addicted to forming their first settlements at the mouths of rivers or creeks, or in land-locked bays and inlets. They are a pre-eminently maritime or semi-aquatic people, to whom a canoe is a necessary of life, and who will never travel by land if they can do so by water. In accordance with these tastes, they have built their houses on posts in the water, after the manner of the lake-dwellers of ancient Europe; and this mode of construction has become so confirmed, that even those tribes who have spread far into the interior, on dry plains and rocky mountains, continue to build in exactly the same manner, and find safety in the height to which they elevate their dwellings above the ground.

These general characteristics of the abode of savage man will be found to be exactly paralleled by the nests of birds. Each species uses the materials it can most readily obtain, and builds in situations most congenial to its habits. The wren, for example, frequenting hedgerows and low thickets, builds

its nest generally of *moss,* a material always found where it lives, and among which it probably obtains much of its insect food; but it varies sometimes, using hay or feathers when these are at hand. Rooks dig in pastures and ploughed fields for grubs, and in doing so must continually encounter *roots* and *fibres.* These are used to line its nest. What more natural! The crow, feeding on carrion, dead rabbits, and lambs, and frequenting sheep-walks and warrens, chooses *fur* and *wool* to line its nest. The lark frequents cultivated fields, and makes its nest, on the ground, of grass lined with *horsehair*—materials the most easy to meet with, and the best adapted to its needs. The kingfisher makes its nest of the *bones* of the fish which it has eaten. Swallows use clay and mud from the margins of the ponds and rivers over which they find their insect food. The materials of birds' nests, like those used by savage man for his house, are, then, those which come first to hand; and it certainly requires no more special instinct to select them in the one case than in the other. But, it will be said, it is not so much the materials as the form and structure of nests, that vary so much, and are so wonderfully adapted to the wants and habits of each species; how are these to be accounted for except by instinct? I reply, they may be in a great measure explained by the general habits of the species, the nature of the tools they have to work with, and the materials they can most easily obtain, with the very simplest adaptations of means to an end quite within the mental capacities of birds. The delicacy and perfection of the nest will bear a direct relation to the size of the bird, its structure and habits. That of the wren or the humming-bird is perhaps not finer or more beautiful in proportion than that of the blackbird, the magpie, or the crow. The wren, having a slender beak, long legs, and great activity, is able with great ease to form a well-woven nest of the finest materials, and places it in thickets and hedgerows which it frequents in its search for food. The titmouse, haunting fruit-trees and walls, and searching in cracks and crannies for insects, is naturally led to build in holes where it has shelter and security; while its great activity, and the perfection of its tools (bill and feet), enable it easily to form a beautiful receptacle for its eggs and young. Pigeons, having heavy bodies, and weak feet and bills (imperfect tools for forming a delicate structure), build rude, flat nests of sticks, laid across strong branches which will bear their weight and that of their bulky young. They can do no better. The *Caprimulgidæ* have the most imperfect tools of all, feet that will not support them except on a flat surface (for they cannot truly perch), and a bill excessively broad, short, and weak, and almost hidden by feathers and

bristles. They cannot build a nest of twigs or fibres, hair or moss, like other birds, and they therefore generally dispense with one altogether, laying their eggs on the bare ground, or on the stump or flat limb of a tree. The hooked bills, short necks and feet, and heavy bodies of parrots, render them quite incapable of building a nest like most other birds. They cannot climb up a branch without using both bill and feet; they cannot even turn round on a perch without holding on with their bill. How, then, could they inlay, or weave, or twist the materials of a nest? Consequently, they all lay in holes of trees, the tops of rotten stumps, or in deserted ants' nests, the soft materials of which they can easily hollow out.

Now I believe that throughout the whole class of birds the same general principles will be found to hold good, sometimes distinctly, sometimes more obscurely apparent, according as the habits of the species are more marked, or their structure more peculiar. It is true that, among birds differing but little in structure or habits, we see considerable diversity in the mode of nesting, but we are now so well assured that important changes of climate and of surface have occurred within the period of existing species, that it is by no means difficult to see how such differences have arisen. Habits are known to be hereditary, and as the area now occupied by each species is different from that of every other, we may be sure that such changes would act differently upon each, and would often bring together species which had acquired their peculiar habits in distinct regions and under different conditions.

But, it is objected, birds do not *learn* to make their nest as man does to build, for all birds will make exactly the same nest as the rest of their species, even if they have never seen one, and it is instinct alone that can enable them to do this. No doubt this would be instinct if it were true, and I simply ask for proof of the fact. This point, although so important to the question at issue, is always assumed without proof, and even against proof, for what facts there are, are opposed to it. Birds brought up from the egg in cages do not make the characteristic nest of their species, even though the proper materials are supplied them, and the experiment has never been fairly tried of turning out a pair of birds so brought up into an enclosure covered with netting, and watching the result of their untaught attempts at nest-making. With regard to the song of birds, however, which is thought to be equally instinctive, the experiment has been tried, and it is found that young birds never have the song peculiar to their species if they have not heard it, whereas they acquire very easily the song of almost any other bird with which they are brought up. It is also especially worthy of remark that they must be taken

out of hearing of their parents very soon, for in the first three or four days they have already acquired a knowledge of the parent notes, which they will afterwards imitate. This shows that very young birds can both hear and remember, and it would be very extraordinary if they could live for days and weeks in a nest and know nothing of its materials and the manner of its construction. During the time they are learning to fly and return often to the nest, they must be able to examine it inside and out in every detail, and as their daily search for food invariably leads them among the materials of which it is constructed, and among places similar to that in which it is placed, is it so very wonderful that when they want one themselves they should make one like it? Again, we always assume that because a nest appears to us delicately and artfully built, that it, therefore, requires much special knowledge and acquired skill (or their substitute, instinct) in the bird who builds it. We forget that it is formed twig by twig and fibre by fibre, rudely enough at first, but crevices and irregularities, which must seem huge gaps and chasms in the little eyes of the builders, are filled up by twigs and stalks pushed in by slender beak and active foot, and that the wool, feathers, or horsehair are laid thread by thread, so that the result seems a marvel of ingenuity to us, just as would the rudest Indian hut to a native of Brobdignag.

But look at civilised man! it is said; look at Grecian and Egyptian and Roman and Gothic and modern Architecture! What advance! what improvement! what refinements! This is what reason leads to, whereas birds remain for ever stationary. If, however, such advances as these are required to prove the effects of reason as contrasted with instinct, then all savage and many half-civilized tribes have no reason, but build instinctively quite as much as birds do.

Man ranges over the whole earth, and exists under the most varied conditions, leading necessarily to equally varied habits. He migrates—he makes wars and conquests—one race mingles with another—different customs are brought into contact—the habits of a migrating race are modified by the different circumstances of a new country. The civilized race which conquered Egypt must have developed its mode of building in a forest country where timber was abundant, for there is no possibility of the idea of cylindrical columns originating in a country destitute of trees. The pyramids might have been built by an indigenous race, but not the temples of El Uksor and Karnak. In Grecian architecture, almost every characteristic feature can be traced to an origin in wooden buildings. The columns, the architrave, the frieze, the fillets, the cantelevers, the form of the roof, all point to an origin in some

southern forest-clad country, and strikingly corroborate the view derived from philology, that Greece was colonised from north-western India. But to erect columns and span them with huge blocks of stone or marble is not an act of reason, but one of pure unreasoning imitation. The arch is the only true and reasonable mode of covering over wide spaces with stone, and, therefore, Grecian architecture, however exquisitely beautiful, is false in principle, and is by no means a good example of the application of reason to the art of building. And what do most of us do at the present day but imitate the buildings of those that have gone before us? We have not even been able to discover or develope any definite mode of building best suited for us. We have no characteristic national style, and to that extent are even below the birds, who have each their characteristic form of nest, exactly adapted to their wants and habits.

That excessive uniformity in the architecture of each species of bird which has been supposed to prove a nest-building instinct we may, therefore, fairly impute to the uniformity of the conditions under which each species lives. Their range is often very limited, and they very seldom permanently change their country so as to be placed in new conditions. When, however, new conditions do occur, they take advantage of them just as freely and wisely as man could do. The chimney and house-swallows are a standing proof of a change of habit since chimneys and houses were built, and in America this change has taken place within about three hundred years. Thread and worsted are now used in many nests instead of wool and horse-hair, and the jackdaw shows an affection for the church steeple which can hardly be explained by instinct. The Baltimore oriole uses all sorts of pieces of string, skeins of silk, or the gardener's bass, to weave into its fine pensile nest, instead of the single hairs and vegetable fibres it has painfully to seek in wilder regions, and Wilson believes that it improves in nest-building by practice—the older birds making the best nests. The purple martin of America takes possession of empty gourds or small boxes stuck up for its reception in almost every village and farm in America, and several of the American wrens will also build in cigar boxes, with a small hole cut in them, if placed in a suitable situation. The orchard oriole of the United States offers us an excellent example of a bird which modifies his nest according to circumstances. When it is built among firm and stiff branches it is very shallow, but when, as is often the case, it is suspended from the slender twigs of the weeping willow, it is made much deeper, so that when swayed about violently by the wind, the young may not tumble out. It has been observed also that the nests built in

the warm Southern states are much slighter and more porous in texture than those in the colder regions of the north. Our own house-sparrow equally well adapts himself to circumstances. When he builds in trees, as he, no doubt, always did originally, he constructs a well-made domed nest, perfectly fitted to protect his young ones; but when he can find a convenient hole in a building or among thatch, or in any well-sheltered place, he takes much less trouble, and forms a very loosely-built nest.

A curious example of a recent change of habits has occurred in Jamaica. Previous to 1854, the palm swift (*Tachornis phœnicobea*) inhabited exclusively the palm trees in a few districts in the island. A colony then established themselves in two cocoa nut palms in Spanish Town, and remained there till 1857, when one tree was blown down, and the other stripped of its foliage. Instead of now seeking out other palm trees, the swifts drove out the swallows who built in the Piazza of the House of Assembly, and took possession of it, building their nests on the tops of the end walls and at the angles formed by the beams and joists, a place which they continue to occupy in considerable numbers. It is remarked that here they form their nest with much less elaboration than when built in the palms, probably from being less exposed.

A fair consideration of all these facts will, I think, fully support the statement with which I commenced this article, and show that the mental faculties exhibited by birds in the construction of their nests are the same in kind as those manifested by mankind in the formation of their dwellings. These are, essentially, imitation, and a slow and partial adaptation to new conditions. To compare the work of birds with the highest manifestations of human art and science is totally beside the question. I do not maintain that birds are gifted with reasoning faculties at all approaching in variety and extent to those of man. I simply hold that the phenomena presented by their mode of building their nests, when fairly compared with those exhibited by the great mass of mankind in building their houses, indicate no essential difference in the kind or nature of the mental faculties employed. If instinct means anything, it means the capacity to perform some complex act without teaching or experience. It implies innate ideas of a very definite kind, and, if established, would overthrow Mr. Mill's sensationalism and all the modern philosophy of experience. That the existence of true instinct may be established in other ways is not improbable, but in the particular case of birds' nests, which is usually considered one of its strongholds, I cannot find a particle of evidence to show the existence of anything beyond those lower reasoning powers which animals are universally admitted to possess.

ON THE VARIOUS MODES OF PROPELLING VESSELS.

BY PROFESSOR M^cGAULEY.

Some means of transport on water have been used from the earliest times; and as soon as the very rudest bark was invented, efficient modes of propelling it were devised. The principles applied to the propulsion of boats and ships have never varied much. That of the oar, which undoubtedly was the first contrivance employed, is also that of the paddle-wheel and the screw propeller. There is good reason to believe that the ancients used oars only for sculling; and the highest authorities on naval matters affirm that this is the best mode of employing them. We use them almost exclusively for rowing.

The wind offered a very convenient source of power, and, accordingly, navigators soon availed themselves of it. But the ancients placed more confidence in oars for the purposes of war; and hence, for either aggression or defence, they used biremes, triremes, quadriremes, etc., which have given antiquarians such trouble, and the nature of which is still involved in great uncertainty. The employment of oared gallies continued until a comparatively recent period; the Turks and Venetians retained them, long after sailing vessels of a very perfect form had been constructed, and we ourselves did not relinquish them until the reign of Henry VII.

Since my purpose is chiefly to speak of mechanical modes of propulsion, the consideration of sails, as a means of obtaining motion, is almost beside my purpose. The small cost at which power is obtained from the wind will, however, probably cause sailing vessels to continue always in use. The disuse of them as ships-of-war seriously affects our position as the masters of the sea.

Oars, made to revolve in a plane parallel to the sides of a vessel, afforded a paddle-wheel; and hence, in very early times, attempts were made to apply in that way the principle of the oar to the mechanical propulsion of ships. Paddle-wheels, similar to oars, were used by the Egyptians, the Romans, and the Carthaginians. But, until steam became applicable as a source of motion, no kind of mechanical propulsion could be equal to that obtained by means of oars. Hence the invention of the steam-engine, properly so called, and the practical adoption of the paddle-wheel were nearly simultaneous.

Paddle-wheels give rise to a great loss of power, on account of the way in which they enter and leave the water,

and great ingenuity has been devoted to the lessening or removal of this inconvenience. The advantage derived from feathering oars suggested the feathering of the float boards; but, besides that every contrivance for such a purpose must be complicated, and therefore both expensive and liable to accidents, most of the modes of feathering proposed are such as attain their object only when the vessel is at rest, the current produced by her motion not being taken into account by their inventors. The shock and consequent vibration caused by the paddles, when entering and leaving the water, has, however, been greatly lessened by breaking them into portions which successively enter and leave the water.

The unequal immersion of the paddle-wheels, on account of variations of the water line, is another serious inconvenience; and plans have been employed for raising and lowering them, so as to accommodate them to circumstances; but no contrivance for the purpose has been such as to merit its being adopted.

The short distance between the paddle shaft and the steam cylinders would give rise to an obliquity of the connecting-rod, with steam-engines of the ordinary form, that must cause a great loss of power. Hence marine engines are peculiar in their construction; their stroke is shorter, the position of the cylinders is varied according to circumstances; in some cases a connecting-rod is rendered unnecessary by the use of oscillating cylinders, and in others a piston-rod, by the use of trunk engines.

Instead of the paddle-wheel, attempts have been made to use, at each side of the vessel, a chain, having paddles attached to it, and passing round two wheels, its lower part being near the water line; but it was found that the friction of a heavy chain and the complication of the apparatus were fatal to it.

To get rid of the inconvenience arising from the paddles being too much or too little submerged, paddles entirely submerged have been tried. They were laid on their sides, so that their axes were vertical, one being at each side of the vessel, which was indented, so that only a portion of the paddles projected beyond its side. But, as may be supposed, the arrangement did not answer. On the whole, the paddle-wheel has retained, almost unchanged, the form given to it by its first inventors.

The screw propeller, which has nearly superseded the paddle-wheel, has been used for ages in China. The operation of sculling may have suggested it. Oars placed, at an angle, on an axis which was made to revolve in a plane parallel to the vessel's length, would be a screw propeller. It might have been suggested also by the windmill; for a windmill with

four vanes would be in reality a screw with four threads; and Bouquer, in a treatise published in 1747, mentions the application of revolving arms, like those of a windmill, to the propulsion of a vessel. It would be suggested, likewise, by the smoke-jack. Bramah, in 1785, patented the application, to the stern of a ship, of a wheel with inclined fans or wings, like those of a smoke-jack. He was the first to use a stuffing-box for connecting the screw with the prime mover within the vessel. In most of its early applications the screw was suspended at a distance from the stern, and motion was communicated to it by very clumsy means.

In its more perfect form, the screw propeller consists of threads or blades placed on an axis parallel to the keel, and forming segments of a helix or spiral. Its *pitch* is the distance in the direction of the axis between any one thread and the same thread at the point where, if continued, it would complete its next convolution. When there is but one screw, it can be fixed only at the bow or the stern. If at the former, it acts on water at rest, which increases its effect; but it throws water against the bow, which retards the vessel. If at the stern, to prevent interference with the rudder, it is placed in the dead wood, or that portion of the ship which is immediately behind the rudder. In 1768, Pancton suggested the use of one screw, either in the bow or the stern, or a screw at each side. But one of the earliest practical applications of the screw propeller was that by Bushnell, of Connecticut, in 1776. He employed one screw for raising or depressing, and another for propelling a submarine boat, which was intended for the fixing of torpedoes to the sides of hostile ships.

Perhaps no contrivance has afforded more occupation to ingenious minds than the screw propeller; it has been made of every conceivable form, and fixed to the vessel in every conceivable way. The number of patents to which it has given rise are counted with difficulty. It came into very general use soon after it had attracted the serious attention of experimentalists and projectors. But the Government were slow to adopt it. Smith, an Englishman, and an amateur, and Ericsson, a Swede, and an accomplished engineer, may be considered to have practically introduced it into use. Both of them endeavoured to secure the patronage of the Admiralty, but only Smith, whose experiments appear to have been more satisfactory, succeeded; and Ericsson left the country in disgust. Smith required gearing; Ericsson's professional resources enabled him to do without it. Smith used a single screw, consisting of one whole convolution, and also a double threaded screw, each thread of which was equal to half a convolution,—one-sixth of a convolution for each has since been found to

answer much better: and he placed the screw in the dead wood. Ericsson used two propellers, each consisting of short spiral plates, attached to the periphery of a broad thin hoop, which was fixed on arms radiating from the axle. Both propellers were behind the rudder, and revolved round a common centre, the shaft of one being within that of the other, and one being in front of the other. The hinder screw revolved with a greater velocity than the one in front of it, to enable it to act on water already in motion. But an equal advantage would be attained by the use of one screw of a larger diameter.

The slowness of the ordinary marine engine opposed a serious difficulty in the earlier attempts to apply the screw propeller. To overcome this, gearing was used, a very large wheel being made to work into a pinion fixed to the screw shaft. But there are great objections to such an arrangement. Independently of the intolerable noise, the teeth wear out rapidly, and are liable to sudden fracture with any violent strain of the sea. At present, a sufficiently rapid motion is obtained directly from the engines; nor is there any objection to this, since the supposition that the best speed for the piston is precisely that which is best for a canal horse, namely, 220 feet per minute, has for a considerable time been known to be a fallacy.

The screw shaft exerts an enormous thrust, in the place at which it abuts within the vessel, the whole force of impulsion being imparted there; the plate against which it works has been rendered white hot, although a stream of water was constantly flowing over it. Various means have been used to overcome this difficulty. Thus, in some cases, the end of the shaft is made to work against a disc of hardened steel, fixed eccentrically with reference to the shaft, and having a slow motion communicated to it; and in others, against rolling surfaces. In others, steel collars are placed on the end of the shaft, and being immersed in oil, are little liable to heat. Should, however, undue friction arise between the actual rubbing surfaces, new ones come into play, since all the collars are moveable. Other expedients also have been employed for the same purpose.

In the early days of the screw propeller, it was used only as an auxiliary to the sails. When not in use, if left in its ordinary position, it would retard the vessel, and other inconveniences would arise from it. To obviate these, means were used for raising it when desirable, and even for closing the aperture in the dead wood, which if left open must seriously interfere with the steering.

Centrifugal force disperses the water, causing the screw to throw it off in the form of a cone; it is far better that it should assume the shape of a cylindrical column. This has been

effected by setting the blades, not at right angles to the screw shaft, but in such a way that they point outwards from the stern. Their tendency is, then, to concentrate to a point the water thrown off by them; and centrifugal force corrects this, so as to give the water the form of a cylinder. Such an arrangement gives excellent results.

The action of the screw is greatly affected by adverse winds, currents, variation of the depths of immersion of the vessel, etc. But, as the velocity with which it revolves is almost invariable, whether the progress made is great or little, the consumption of power is, in nearly all cases, the same. It is otherwise with the paddle wheel, which in similar circumstances revolves more slowly. To meet this difficulty, means of altering the pitch of the screw blades, according to circumstances, have been devised; and of the plans proposed for the purpose, those of Bennet Woodcroft are the most remarkable for ingenuity and effectiveness.

To obviate the loss of power from portions of the blades effecting very little more than a dispersion of the water, the leading edge of the screw has in some instances been made nearly at right angles with the axis of the shaft, the pitch increasing slowly at first, and then rapidly, so that the trailing edge should stand on a line with the axis of the shaft. But the large amount of rubbing surface thus produced neutralizes the theoretically excellent qualities of this form of blade; and it has been greatly improved by cutting away a considerable amount of its leading edge near the periphery.

Not only has any interference of the screw with the steering been prevented, but it has been made a most effective auxiliary to, and even substitute for, the rudder. An application of the screw propeller in this way was suggested so early as 1800 by Shaler, and was carried into effect in 1803 by Dallery, who arranged it in such a way that it was turned with the rudder without its revolution being interfered with. Bennet Woodcroft, in 1851, devised a means of manœuvering the vessel, by causing the blades to feather, so as to pass edgeways through the water during one part of their revolution, and sideways during another. The application of the twin screw affords so excellent a steering apparatus, that by means of it a ship, even in still water, may be made almost to revolve on its centre. The twin screw has, besides, other advantages of so important a kind, that it is likely to be exclusively employed hereafter in the navy, and very generally in the mercantile marine. It affords a perfect substitute for the rudder, should the latter get out of order: if one screw is disabled by accident, there is still a propelling power: and it allows the vessel to be moved with equal velocity ahead or astern. It has been brought

forward at various times since the screw propeller first attracted attention, but its excellent qualities were not completely utilized until each screw was worked by separate engines. Even with these, which may be comparatively light and inexpensive, it secures great economy of space. A twin screw renders the navigation of the most difficult channels easy, and it is invaluable with a turret ship.

Of all the questions connected with the screw propeller, that of the *slip* is the most interesting and important. The screw propeller advances through the water—carrying the vessel along with it—in the same way as a metallic screw advances in a fixed solid nut. Were the nut of water in which the propeller works, as immovable as the fixed solid nut, the velocity of the ship and that of the screw would be equal. But, as the water *must*, to a certain extent, give way, the velocity of the ship must be less than that of the screw; and the difference of these velocities is termed the "positive slip." The latter is easily accounted for, to its full extent. Whatever may be the apparatus used for propulsion, any motion imparted to the water is so much lost, since none of it is communicated to the vessel. Fortunately this loss may be diminished; with the paddle-wheel, it is lessened by enlarging the float-boards; with the screw, by increasing its size, which may easily be made such as will render it superior to paddle-wheels. Care must be taken, however, that the additional friction produced does not counterbalance any advantage gained in this way.

A large amount of positive slip may be due to centrifugal force. When the vessel is retarded by adverse winds or currents, etc., the water may be so propelled centrifugally by the screw, that there will be an empty space at its centre. This may be prevented by deepening the screw in the water; the height of the column of fluid above it will then cause the particles to flow in, so as to rapidly fill the space which would otherwise be vacant.

The slip of the paddle-wheel cannot be decreased, like that of the screw, since the more it is enlarged, the more disadvantageous the angles at which the floats enter and leave the water. A paddle-wheel of small diameter, or a screw of small pitch, has a large power of traction, but with each the slip is considerable. Increasing the diameter of the screw, without altering the pitch, reduces the slip, without rendering it necessary to change the velocity of revolution. If the slip is judiciously decreased, the screw propeller becomes superior in efficiency to the paddle-wheel.

There is another variation between the velocity of the screw and the vessel, which, though it would seem impossible, undoubtedly exists. The vessel, in some cases, seems to go

faster than if the screw worked in a solid substance; and this excess of velocity of the vessel above that of the screw has been termed the "negative slip."

The negative slip has been accounted for in various ways, and is, perhaps, due to a variety of causes. It may, to some extent, be explained by a twisting of the blades which is consequent on the strain, and is equivalent to an increase of pitch. Screws with a fine pitch are more liable to it than those with a coarse. A more effective cause of the negative slip is perhaps found in the column of water that always follows a ship to fill up the space which is left vacant by the progress of the vessel. The forward motion of this current may more than counterbalance the positive slip which must, in every case, occur. More pressure, and therefore more power of resistance, is given to the water in which the screw is immersed, than are found in the surrounding water, also, by the mass of fluid which is elevated, at the stern, by the screw itself. The constant action of these two causes must always render the apparent less than the real positive slip.

The last mode of propulsion to which we shall direct the attention of the reader is the application of that reaction which is produced by fluid issuing from apertures. I shall say nothing of the numberless contrivances that have been constructed on the principle of ducks' feet—opening when intended to act on the water, and folding up when they were to be drawn in the opposite direction. Some of these are very ingenious, but all of them, if liable to no other objection, are of necessity so complicated, and so liable to injury, that their adoption would be out of the question.

The reaction produced by a stream of fluid is the source of motive power in Hero's engine, invented more than two thousand years ago at least, and of Barker's mill; and it is used in the rocket, and many other kinds of fire-work. Nature herself employs it as one of her sources of propulsive power; the stream of water emitted by the gills of fish acting as an auxiliary to the action of their fins. The application of this principle to the propulsion of vessels holds out peculiar advantages. Like the screw, it affords a means of aiding the rudder, and even rendering it unnecessary; it is very easily applied, the apparatus used with it being very simple, and less liable than even the screw to injury from external causes. Contrivances founded upon it were among the earliest which have been proposed as substitutes for the ordinary modes of propulsion; and, although they have been so long unsuccessful in the contest, there is some reason to suppose that they may yet supersede all others. They are beset, however, essentially with great difficulties, which the unskilfulness of the earlier experi-

mentalists rendered more serious than they naturally are. But it still remains a question whether or not these difficulties may be so far overcome that any contrivance of the kind can compete, not only in efficiency, but—which is of, at least, equal importance—in economy, with those already in use.

Toogood, in 1661, and after him Allen, in 1730, proposed to propel a vessel by means of a jet of water. Bernouilli, Linaker, Ruthven, and many others, at different periods, followed in the same path. With all such apparatus there must be a loss of power, on account of the necessary changes in the direction in which the fluid moves, and the great friction arising from the large amount of rubbing surface. The friction of fluids against solids is so great, that the advantage derived from a long sharp bow may be more than counterbalanced by the increased length of the vessel. The friction was enormously increased in the earlier contrivances by the extreme narrowness of the waterways. This led to another evil,—the smallness of the issuing current. The reaction of the water against which this current impinges can be great, and therefore a sufficient amount of resistance can be obtained, only when the issuing stream is considerable.

The principle of all such contrivances must be the same; the only difference consists in the mode of applying it. This has been extremely varied. In some instances pumps have been used; in others, a horizontal water wheel, or turbine, inclosed in a case, the water being drawn in generally at the bow or the bottom of the vessel, and emitted at the stern or the sides. In no department of practical science has the same thing been invented over and over again so often as in this.

Some interesting experiments are being made in America with a vessel, at each side of which the fluid is made to issue from pipes that are near the water-line, and are capable of being turned either towards the stern or the bow, so as to impel the vessel ahead or astern; or, if those at opposite sides are turned in opposite directions, so as to turn it round.

Still more important experiments are being made in this country with the "Waterwitch." This vessel is fitted with a turbine wheel, fourten and a half feet in diameter, working in a chamber which, ordinarily, has no connection with the rest of the vessel. The water enters from the bottom of the vessel, through gratings, and issues by means of two pipes, running the whole length of each side of the vessel, and so arranged that the fluid may escape from both orifices at the stern, or both at the bow, or from one at the bow and another at the stern, so as to turn the vessel on her centre. The issue of the water is regulated by sluices, which are under the control of an officer on deck, and can be worked without altering or

stopping the engines. Should the vessel leak, the water may be obtained from its hold instead of from the sea; and thus, by the very act of propulsion, the vessel will be kept afloat. Satisfactory velocities have been obtained by the "Water-witch;" but the real question is that of economy, and regarding this no satisfactory data has yet been given by the experiments hitherto made. The only novelty in either the American vessel or the "Waterwitch" consists in ingenious combination of details which have long been known. The position of the exit tubes in the American experiment is evidently bad. They are exposed to injury, and the resisting medium is far inferior in efficiency to what it would be were they at some depth below the surface of the water.

Oars have been in a great degree superseded by sails, sails by paddle wheels, paddle wheels by the screw, and now the screw appears not unlikely to be set aside by a contrivance founded on a principle which is perhaps as old as most of them. How many valuable principles are allowed to remain for ages without practical application? The most important triumphs of science, those which have had the most effective influence on progress, are but developments of facts and principles that were long known.

SUN VIEWING AND DRAWING.

A READY METHOD FOR OBSERVING AND DEPICTING SOLAR PHENOMENA, BY MEANS OF PROJECTING THE SUN'S IMAGE UPON A SCREEN.

BY THE REV. FRED. HOWLETT, M.A., F.R.A.S.

(*With a Tinted Plate.*)

Seldom has the writer met with an instance wherein very simple means and cheap appliances have, at least in a certain special line of astronomical observation, commanded better results, than the one which it is proposed to make the subject of the following paper. With respect, then, to the investigation of the sun it is encouraging to amateurs to know how much good work may be done by the aid of only a very moderate-sized telescope, in combination with a few simple and inexpensive accessories presently to be described.

Anyone possessing a good achromatic of not more than three inches aperture, who has a little dexterity with his pencil, and a little time at his disposal (all the better if it be at a somewhat early hour of the morning) shall be made acquainted with an easy method whereby he may deliberately and satisfactorily view, measure, and (if skill suffice) delineate most of

those interesting and grand solar phenomena of which he may have read, or seen depicted, in various works on physical astronomy.

We mean not to say, of course, but what very superior views of these phenomena may be obtained by means of those splendid instruments which are now to be found in the possession of not a few devoted lovers of astronomy, both amateur and professional; and we are aware, too, that it is only in the new, and fascinating, and important field of spectrum-analysis, specially in the hands of such sagacious observers as Kirchhoff, Huggins, Miller, Secchi, Donati, Alexander Herschel, and others—armed with special and variously-modified apparatus for the purpose—that our knowledge of the *chemical* constitution of the sun and other celestial lights can be promoted; but still it is not too much to say, that, with the sole exception of the much disputed "willow-leaf," or "rice-grain" shaped entities (asserted by Mr. Nasmyth and other high authorities to lie scattered in a nearly uniform but confused and interlacing stratum over the whole solar surface), a good achromatic telescope of only three inches aperture, and armed with a magnifying power of from 120 to 200 linear, will, if employed in the manner about to be explained, reveal nearly every solar phenomenon which up to the last ten or a dozen years was known to the scientific world.

And even as regards these last mentioned "entities" (what to call them exactly, we know not), which were described as being about from two to three seconds in length by about one-eighth or so of those measurements in breadth, though they certainly are not individually and separately to be seen by the aid of a telescope of only three inches aperture, yet may they possibly be recognized (if indeed they really exist) flaked together in those small, irregular, closely-approximated masses termed the "coarser granulations," or the "mottling" of the solar photosphere.

This mottling may be readily descried on days of steady definition by direct vision by any tolerable telescope (using of course some kind of darkening-glass in order to protect the eye from the glare and heat); but a much more distinct view of this remarkable structure of the sun's surface may be obtained by projecting the solar image on a screen, all due care being taken to procure the best and most perfect effect, by attending both to the best amount of magnification, and to the sufficient darkening of your chamber or observatory.

Many a reader, probably, of the INTELLECTUAL OBSERVER has seen the solar spots by ordinary direct vision through a telescope; and if the spots have been of a tolerable size, he will have been perhaps considerably interested in the sight. But,

unless exceptionally interested in the matter, he will soon probably be inclined to discontinue his observations (even though well disposed towards them), both on account of the difficulty with which the details of any but quite the larger spots can be descried by a merely ordinary instrument, the tediousness of keeping them in the field of view, the difficulty of recovering them, often, when lost, especially when use is being made of the higher powers; and lastly, the heat and glare with which the investigations of the glowing face of Father Sol are, under such circumstances, attended.

The writer remembers well the discouragements with which, in his novitiate, he had to struggle; whilst nevertheless (owing to the urbane encouragement of a world-honoured name in science)* he continued his solar record, with perhaps a moderate amount of success, but certainly an immoderate amount of *trouble.*

It had been long known, however, that an image of the sun could be thrown down the tube of the telescope upon a sheet of white paper (the focussing being duly attended to, and made a trifle longer than that required for direct vision), and that the existence of a solar spot could be readily made manifest by this method, as it is termed, of *projection.*

The writer had often noticed also that any specks of dust, or moisture, or what not, that might happen to be lying at the time upon the lenses of the eye-piece, were also faithfully though annoyingly projected likewise on the paper; though by rotating the eye-piece ever so little it was at once apparent which were solar and which mundane phenomena, inasmuch as the positions of the former were not at all affected by the rotation of the eye-piece, whilst the latter rapidly described portions of a circle, commensurate with the amount by which the eye-piece had been turned.

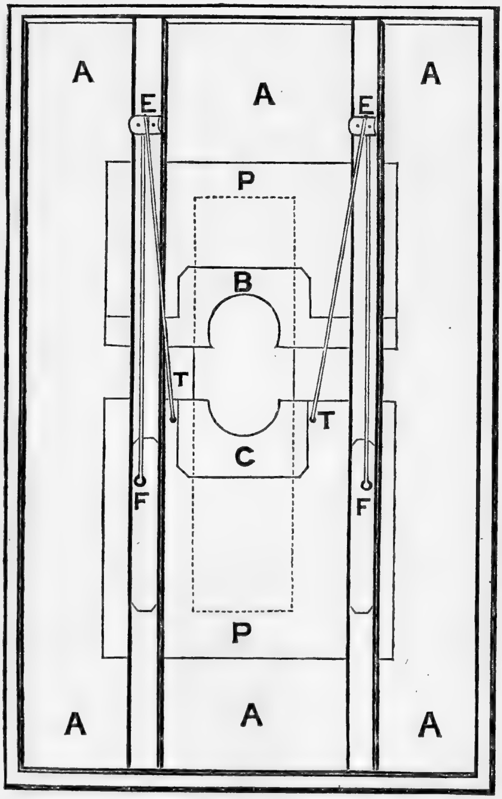
So at length after various experiments with spots and specks, the question arose—Why not systematically examine, measure, and depict solar phenomena by means of projection, on the largest convenient scale, and under the most favourable circumstances attainable? And this question was soon put into practice; the result being a collection of solar drawings and measurements, of about six years continuance, which, though exceeded certainly both in numbers, and in certain very important points, in scientific interest, by those of other indefatigable and sagacious observers,† as well as by the highly valuable photographic records carried on at Kew and at Ely, have not yet been excelled perhaps, as a *collection,* for minuteness of micrometric detail.

* Sir J. F. W. Herschel, Bart., of Collingwood, Hawkhurst.

† Viz., Schwabe, Wolff, Pastorff, and last, not least, Carrington.

Hence it is of great importance that these large hand drawings should be diligently maintained by as many competent observers and draughtsmen as possible, until Heliophotography shall have happily succeeded in obtaining abundance of detail of solar phenomena, on a very much larger scale, and with far more distinctness than has yet been accomplished, save in a few isolated instances. The difficulties, indeed, which beset Heliophotography are immense; but who can say what may not at last be accomplished by the talent, perseverance, and liberality of De La Rue, Selwyn, and their coadjutors and assistants, in the comparatively new and wonderful art of celestial photography? Very much has been done already, and we sanguinely hope that more is yet to follow.

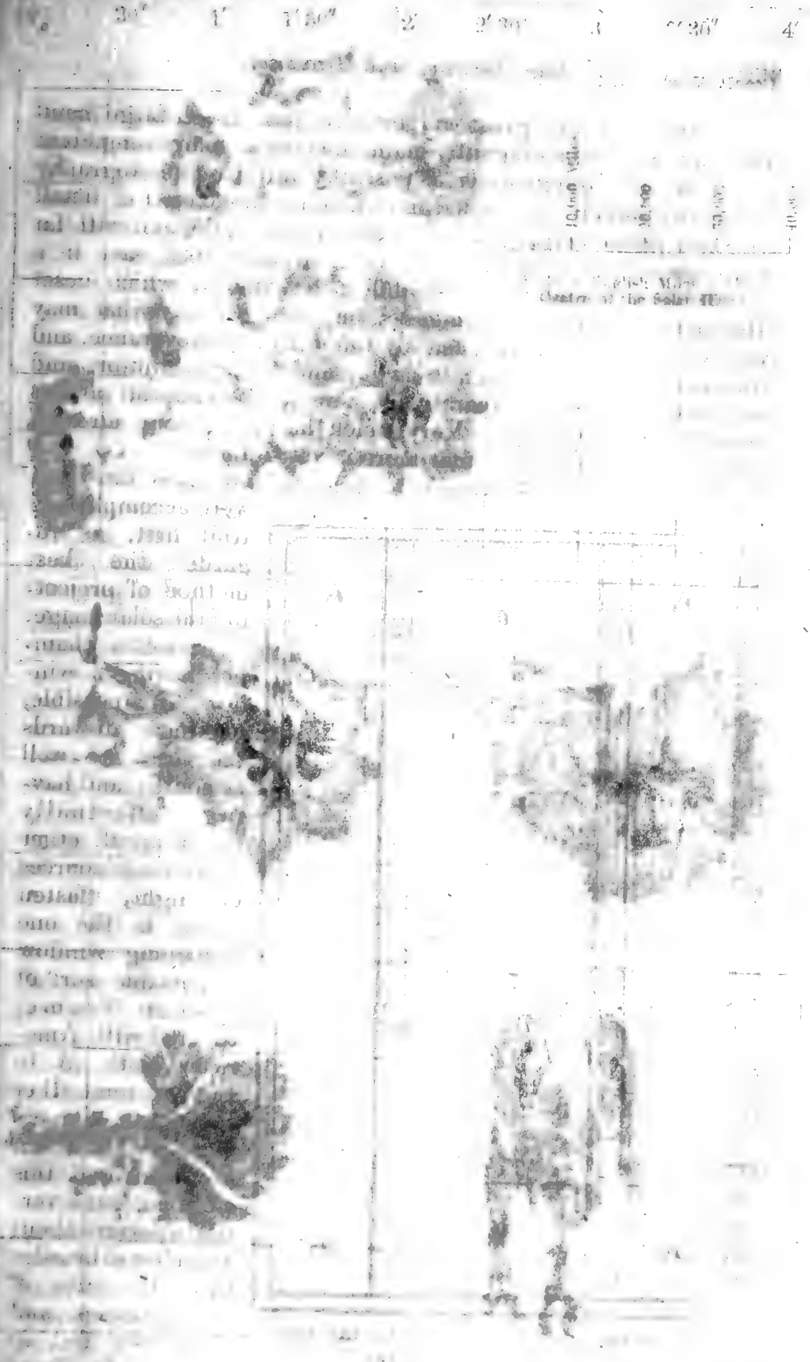
But we must now proceed to describe how these drawings were accomplished. And first, as regards the best method of projecting the solar image.



DARKENING SHUTTER, FOR VIEWING THE SUN BY PROJECTION ON A SCREEN.

Select a chamber having a window, if possible, looking towards the east as well as south; and having effectually closed up all other windows or sources of light, fasten neatly in the one remaining window a portable sort of wooden frame, covered with American cloth (A in Fig.), or some other substance impervious to light. In the centre of this cloth cut out a vertical aperture about an inch or so broader than the tube of your telescope, and about two feet in length. In front of this aperture, set up, by means of slender wooden bars,

Minutes and Seconds of Celestial arc.



... been projected on a Screen; and ... same scale ...
... drawn by the aid only of a low ... Power ...

2.—1884, Jan. 24, ... m.

3.—Jan. 25, 11 a.m.

4.—Jan. 28, Noon.

... Noon.

... "bizarre" spot.

... "grotesque" spot.

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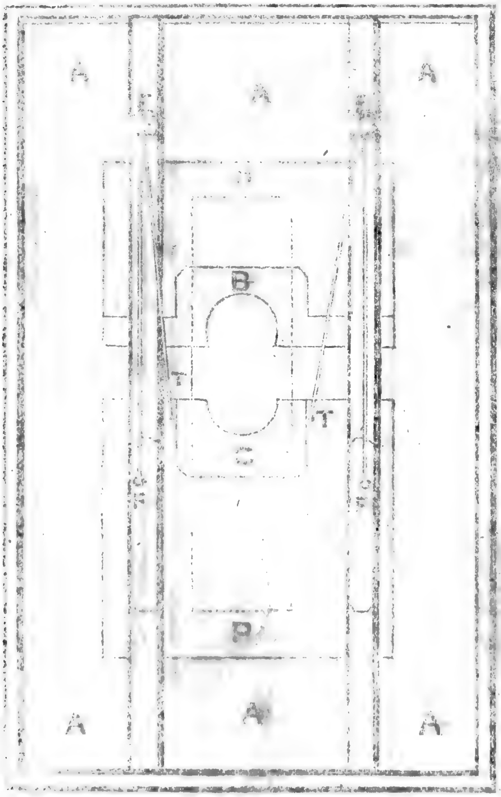
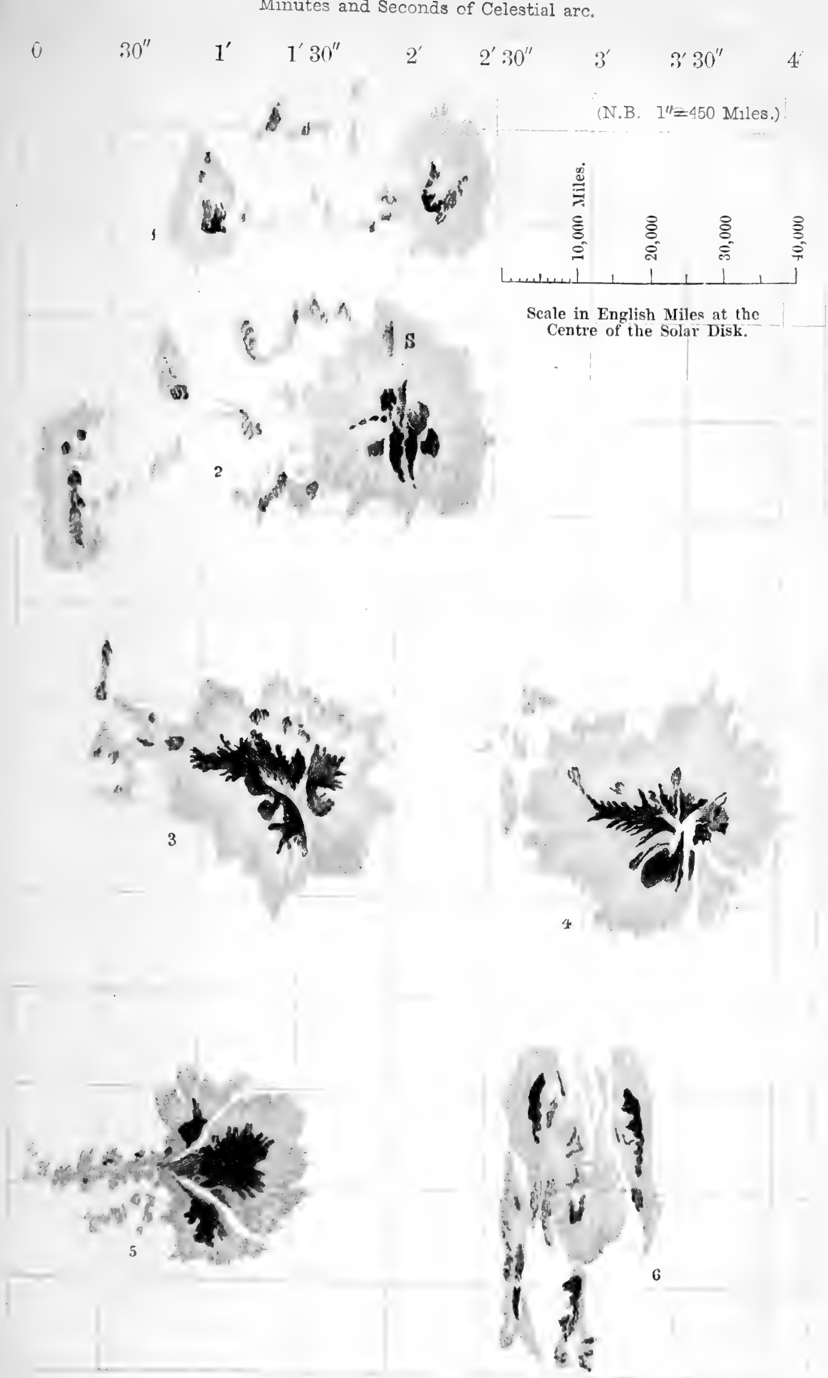


DARKENING SHUTTER, FOR VIEWING THE SUN BY PROJECTION ON A SCREEN.



VARIOUS SOLAR SPOTS,
As seen projected on a Screen; all to the same Scale; and as observed and measured by the aid only of 3 Inch aperture, Power 120 linear.

Fig. 1.—1864, Jan. 24, 2 p.m.
Fig. 2.—Jan. 25, 11 a.m.
Fig. 3 —Jan. 28, Noon.
Fig. 4.—Jan. 29, Noon.
Fig. 5.—1865, Feb. 17, Noon. A "bizarre" spot.
Fig. 6.—1865, Aug. 5, 8.20 a.m. A "grotesque" spot.

[illegible]

two moveable pieces of stout pasteboard (P), or, rather, let us say one piece, cut *horizontally* into two. At the centre of this line of bisection cut out a semi-circular hole (B) from the upper piece of pasteboard, and a similar corresponding one (C) from the lower one; so that these two holes, when brought together, form a circle, which should be about two inches wider than the diameter of your tube. Round the edges of each of the semicircular orifices sew on (and glue likewise) a thickish piece of opaque vulcanized India-rubber (B and C), so that the elastic material may closely embrace your tube, but still allow your instrument a considerable range, both in altitude and azimuth. It will be far better, too, if the edge of the lower piece of the cardboard is arranged, so that when closed it may overlap the upper piece: otherwise it will be exceedingly difficult to prevent extraneous beams of light from entering through the interstices, and seriously interfering with the definition of the solar image on the screen. For this end, indeed, it will be necessary that the orifices in both the pieces of India-rubber should be cut rather semi-elliptical than semi-circular.

It will also be found extremely convenient to have pieces of tape (T T) fastened to the top of the lower piece of cardboard, and then passing upwards over, and behind two bottle-corks screwed down to the bars of wood at E, E, and then passing down again, and pinned, when requisite, to the two long, flat pieces of cork glued to the bars at F, F. By this means, after having directed your telescope upon the sun, you may at once effectually close your pieces of pasteboard, without any possibility of the lower piece slipping down again, which otherwise would frequently and annoyingly happen.

Note.—The place occupied by the large vertical hole in the American cloth is indicated in the Fig. by the coarsely-dotted rectangular line, except where its outline is represented, unbroken, between the two temporarily-separated pieces of pasteboard.

Next prepare your screen. The one employed by the writer is a sheet of "continuous drawing-paper," three and a half feet in length by nearly three feet in breadth, fastened down by a slight wooden frame upon a foundation of mill-board. This is placed on an easel, the legs of which are furnished with holes and pegs, so that the screen may be set at any height, as well as also placed at any requisite angle. Provide, also, a large T square, of light wood, by means of which you may at any moment see that the face of the screen is adjusted (and maintained) at right-angles to the line of collimation of the telescope—to the visual axis, that is, of the tube.

If now you draw apart the two semi-circular orifices above alluded to, you may readily direct your telescope upon the sun (without dazzling your eyes, as in the ordinary method whilst so doing), by so adjusting the tube, that the dark *shadow* cast by it upon the screen shall be a perfect circle. Then, having closely drawn the India-rubber round the telescope, and duly attended to the focussing, a perfectly defined and most pleasing image of the magnified solar-disc will exhibit itself, on a scale more or less enlarged, according to the power of the eye-piece employed, or the distance the screen is placed from the telescope. As a general rule, about one yard may be recommended as a convenient distance for producing an excellent effect with almost any eye-piece that the state of the atmosphere will admit of.

It will be found that, by shifting the tube slightly with the hand, the whole solar disc may be very rapidly and effectually scrutinized, with no more strain to the eyes than if it were being presented to you on a chart; and with a power of—say about sixty or eighty linear—the most minute solar spot, properly so called, that is capable of formation (for the writer believes they are never less than three seconds in length or breadth), will be more readily detected than by any other method; as also will any faculæ, mottling, or, in short, any other phenomena that may then be existing on the disc.*

The darker your chamber (your camera obscura, in fact) is, the more vivid and satisfactory are the results; and the writer will not easily forget the feelings with which he in this manner watched the progress of the solar eclipse of July 18th, 1860, along with his friends.

Drifting clouds frequently sweep by, to vary the scene, and occasionally an aërial hail or snow-storm, as mentioned by Mr. Browning in the number of the *Register* just alluded to; and the writer has more than once seen a distant flight of rooks pass slowly across the disc with wonderful distinctness, when the sun has been of a low altitude, and likewise, much more frequently, the rapid dash of starlings, which, very much closer at hand, frequent his church tower.

A transit of any of the inferior planets is also beautifully apparent by this method, as was witnessed by the Honourable Mrs. Ward, on November 12th, 1861, and agreeably recorded by that talented lady in an illustrated article in the very first number of the INTELLECTUAL OBSERVER.

* An instance of the facility of this method for detecting a very small spot is afforded by the fact, that, in the various accounts of the late eclipse of March 6th, 1867 (recorded in the *Astronomical Register* for the month following), almost all concur in stating that no spot was observed on the sun, whereas there most certainly was one spot visible about eight seconds in length.

Before proceeding to describe the method of *measuring* the spots, or other solar phenomena, it may be well to refer the reader to the Plate accompanying this paper, wherein may be seen micrometric drawings of various solar spots, the first four figures of which show the precise size and general appearance they presented on the screen (save that the attendant faculæ are omitted), and as they were then and there depicted. The two last figures were originally viewed and drawn under optical appliances of double power, and have been consequently reduced one half, linear, in order that the same scale might serve for all alike, viz., about 27,000 English miles to the inch; or, astronomically speaking, on this same scale one minute of celestial arc subtends one inch, and every second of this minute measures about 450 English miles near the centre of the disc, where the effects of foreshortening, produced by viewing objects on the surface of a sphere, are reduced to the minimum.

Sir John Herschel has alluded* to the bizarre, and even grotesque appearance assumed at times by the solar spots. And truly this circumstance with regard to them is occasionally not a little remarkable; and before describing more particularly the phenomena which frequently characterize an ordinary and well-developed spot, we would call attention to Figs. 5 and 6 in the Plate, wherein Fig. 5 (which is not in the slightest degree exaggerated in form and symmetry) will probably be allowed to bear a very close resemblance to the petal of a geranium, or perhaps, picotee, or other flowering plant, according to fancy; whilst Fig. 6, affected, it is true, by a high degree of foreshortening, the most advanced border of the spot being not more than ten seconds from the preceding limb of the sun, may suggest to a lively imagination the belief that the uncouth gallinaceous bird, *Didus ineptus* (the Foolish Dodo), though said to be now extinct as a terrestrial species, is still to be reckoned among the fauna of the sun! By such comparisons, at any rate, may the mind be diverted occasionally, if only the whim be not allowed to warp the hand, whilst studiously transferring a representation of the solar spots from the screen to the sketch-book.

The writer has preferred to delineate this case of *Didus ineptus* as an instance of the grotesque, rather than another one still more remarkable, simply because it so happens that a photographic record of the occurrence of that *rara avis* was secured by Mr. John Titterton, of Ely, for Professor Selwyn, and to which, therefore, some of the readers of the INTELLECTUAL OBSERVER may be able, perhaps, to refer, though they must be reminded that the photographs represent the solar image and

* See Herschel on the Solar Spots, *Quarterly Journal of Science*, No. II., p. 224.

phenomena on only a very small scale. A yet more striking instance of both the bizarre and grotesque combined might have been adduced by the writer in the case of a magnificent group of spots which was thus alluded to in a paper read by him before the Royal Astronomical Society:*—"I have only one more subject to mention, and that is, that I hope some one else beside myself took notice of and depicted, or, better still, secured a photograph, of a most curious phantom-looking group of spots, which at 1 p.m. on the 4th January of this present year (1863) exhibited an appearance so wonderfully like a human skeleton that, in a less superstitious age than the nineteenth century, its portentous shape might easily have raised considerable apprehension in the minds of the multitude. Being Sunday when this was observed, and being much occupied with the more immediate duties of the day, I did not draw the group with micrometric correctness, but simply took a rough sketch of the phantom, which subtended about 5′ 40″ of arc of the solar surface, or 153,000 miles, and respecting which (as I observed lately to Admiral Manners†) I am really not aware that any love for the marvellous induced me to exaggerate in any degree the singularity of its proportions. Sheet 96 exhibits this group as it appeared, when much altered, on January 7th."

Having already alluded to the most convenient way of projecting the sun's image on the screen, we now proceed to explain how the spots, etc., may be accurately measured. Cause your optician to rule for you on a circular piece of glass a number of fine graduations, the $\frac{1}{200}$th part of an inch apart, each fifth and tenth line being of a different length, in order to assist the eye in their enumeration. Insert this between the anterior and posterior lenses of a Huygenian eye-piece of moderate power, say 80 linear. Direct your telescope upon the sun, and having so arranged it that the whole disc of the sun may be projected on the screen, count carefully the number of graduations that are seen to exactly occupy the solar diameter. A correct eye is requisite in order to judge precisely where any one diameter lies. By means of practice, however, this may soon be done with the greatest facility; and, inasmuch as the sun's disc is a perfect sphere, being neither oblate nor prolate in the slightest appreciable degree,‡

* See *Monthly Notices, Royal Astronomical Society*, vol. xxiii., p. 273, for Nov. 1863.

† The Foreign Secretary of the Royal Astronomical Society.

‡ This is the dictum of our present Astronomer Royal, Professor Airy; and Professor Brayley, in a very interesting article on the physical constitution of the sun, in the *Companion to the Almanack*, for 1864, says, that "the sun is the only body of the solar system having that figure, and the only known example of a perfect sphere in nature."

it matters not in which direction you measure your diameter, provided only the sun has risen some 18° or 20° above the horizon, and so escaped the distortion occasioned by refraction, which he will have done at such an altitude as that just mentioned, at any rate for any such purpose as we now are considering.

Next let us suppose that our observer has been examining the sun on any day of the year, say, if you choose, at the time of its mean apparent diameter, viz., about the first of April or first of October, and has ascertained that (as is the case with the writer) sixty-four graduations occupy the diameter of the projected image. Now the semi-diameter of the sun, at the epochs above mentioned, according to the tables given for every day of the year in the *Nautical Almanack* (the same as in Dietrichsen and Hannay's very useful compilation), is 16′ 2″, and, consequently, his mean total diameter is 32′ 4″, or 1924″. If now we divide 1924 by 64, this will of course award as nearly as possible 30″ as the value in celestial arc of each graduation, either as seen on the screen, or as applied directly to the sun or any heavenly body large enough to be measured by it.

Astronomers assure us, moreover, that the mean solar diameter is (according to the latest corrections) about 848,435 miles. Hence, if we divide this vast number of miles by sixty-four, we find that each graduation of 30″ subtends also 13,256 miles, or about 442 miles to each second of arc on the sun's surface. It is thus evident enough how any solar spot or facula, or other visible phenomena, may be readily measured. The telescope must simply be directed with the hand, so that any object that may be visible on the sun's surface may be brought up to the graduations seen projected also on the screen. Remembering, as we have explained above, how every graduation is equivalent to 30″, or (since one second = 442 miles) to thirteen thousand two hundred and fifty-six miles. It certainly was very accommodating that each division on the glass of $\frac{1}{200}$th of an inch should turn out to be equivalent to the neat amount of 30″, or half a minute precisely of arc; but so it was in the writer's experience, in combination with a Huygenian eye-piece magnifying 80 times linear.

It might be tedious to the reader to explain how an exact (or approximately exact) estimation of solar measurements was attained to in the case of higher eye-pieces not provided with graduated glasses, which, by the way, do not of course improve the definition of the instrument, though they do not very much interfere with it so long as they can be kept free from dirt, but especially from *moisture*, which last, however, seems to have a special aptitude for condensing upon the

interposed disc of glass, so that it will be found expedient frequently to wipe it. The Huygenian lenses themselves always remain remarkably free from any such condensation, the cause for the difference resulting, probably, from the different qualities of the glass itself.

It was observed above that the apparent size of any solar object visible on the screen was smaller or larger according to the distance which intervened between the screen and the eye-piece; and it was eventually found that when a power of 120 linear was employed, and when the screen was placed just five feet two inches from the eye-piece, one of the graduations cf 30″ of arc, measured upon the screen exactly *one inch.* Hence, of course, half an inch upon the screen was equivalent to 15″ of arc, and this scale is, perhaps, as convenient and instructive as any, for the purpose of depicting solar phenomena, which may be comfortably copied at once off the screen upon transparent tracing paper, ruled across at regular intervals with faint lines, forming squares half an inch in size.* Lead pencils of the best quality should be employed in delineating the solar spots, the observer sitting in his camera obscura, with his back of course to the window shutter, and holding his tracing-paper somewhere or other within the cone of rays which diverge from the eye-piece, and which affords abundant illumination for the purpose in hand.

When using the ordinary Huygenian astronomical eye-piece in connexion with the screen, the projected solar image will be seen reversed, but *not* inverted as when the sun is viewed by direct vision. The disposition of the image is, however, otherwise affected by projection (it is turned inside out, as it were), and in order to correct all optical freaks and represent the phenomena as they would really appear in the *terrestrial* eye-piece, it will be necessary both to reverse and also invert the drawings on the tracing-paper, gumming them down (if it is wished to preserve them) upon uniformly-sized sheets of very pale stone-coloured drawing-paper, which can be bound up into volumes for reference.

The drawings are thus preserved from any possibility of being smudged, whilst at the same time the slightest mark of the pencil will be visible through the transparent tracing-paper. The faculæ—a very delicate feature to delineate—should be carefully executed in Chinese white with a camel's hair brush, avoiding a too abrupt and harsh outline. But inasmuch as the Chinese white is apt to be nearly obliterated when treated with the gum-arabic, the faculæ should

* Messrs. Droosten and Allen, of the Strand, London, makes up convenient-sized block-books of this tracing-paper, interleaved (as is necessary) with a white opaque paper, as a contrast to the pencil marks.

at first be only very faintly indicated with the lead pencil in the drawing, and then the Chinese white applied after the drawing has been gummed down. The object in using tinted paper as the foundation, is in order that the faculæ may be the more plainly apparent, by contrast.

But there is another point of much importance, which should be attended to by any one who is making a study of solar phenomena; and that is, a good approximation at least to the ever-varying apparent positions of the sun's poles and equator. Otherwise it would be impossible to determine whether any group of spots or other phenomena were situated in the sun's northern or southern hemisphere—a matter this of much interest. For it is by no means the case that the top or apparent zenith point of the sun's disc is always his north pole, or the bottom or nadir point is always his south pole. In fact, not only has the solar pole a proper inclination of his own of about 7° to the plane of the earth's ecliptic, but in consequence of the perspective effects produced partly by the earth's revolution in her orbit, but much more by her daily rotation on her own axis, the sun's poles (as referred to our horizon) are never the same for two minutes successively, save at about the hours of six a.m. and six p.m.; as the writer first discovered for himself, with no little interest. Or again, whilst at noon, in England, the sun's north pole in autumn lies many degrees to the *left* of his zenith, it lies just as far to the *right* of it at noon in spring. Thus it is always shifting. How then is this knotty point to be ascertained? How can we declare where his north and south poles lie, bathed in their *landmark-less* incandescent ocean of light?

With an equatoreally mounted instrument this would be a comparatively easy matter, but we are supposed now not to be in possession of such a luxury. But any ordinary telescope may be readily furnished with a thin slip of semi-transparent mother-of-pearl about the sixteenth part of an inch in width, graduated off into divisions the $\frac{1}{100}$th of an inch apart (every fifth and tenth graduation made more conspicuous, as before); and having also an exceedingly fine wire stretched across it in the middle at right angles, and the whole inserted within the focus of your terrestrial eye-piece. When viewing the sun therewith by direct vision, the position of any solar spot may be laid down with sufficient accuracy for most purposes, by throwing the fine wire exactly in a line with the zenith and nadir points of the sun for the time being, and then, whilst it is in this position, bringing up the mother-of-pearl to the centre of the spot, and counting how many graduations it lies to the right or left of the wire; then upon revolving your eye-piece in its screw about ninety degrees (and so bringing the wire into

a horizontal position), and bringing it up in that position to the spot, count how many graduations there are between the wire and either the zenith or nadir point of the sun, and lay your spot carefully down upon a ready-prepared circle drawn on paper by means of a rule, of which say every tenth of an inch shall be supposed to be the representative of each graduation on your strip of mother-of-pearl.

Three observations at least, on any three different days of one and the same spot must be made, taking care that they are as near as possible at the same hour and *minute*, otherwise the observations would be useless. A different method, however, is employed by the writer, which cannot here be described in detail. Now, after having secured three good observations on one circle on your paper, a line drawn through these three points will describe part of a circle of solar latitude; and a line drawn at right angles to this circle of latitude would (if drawn through the *centre* of the disc on paper) indicate the poles. Otherwise due allowance must be made for the effects of perspective upon the surface of a sphere, in order to judge of the positions of your solar latitude and longitude; bearing in mind, too, the fact that, owing to the sun's poles having a proper inclination of their own of about seven degrees to the plane of the earth's ecliptic, the north pole of the sun lies a little way within the top of the visible disc from July to December; and his south pole, in turn, a little way within the bottom of the disc from December to July.

About the middle of June and middle of December, the two poles lie just upon the very margin of the visible disc; and consequently parallels of latitude then appear to form with one another straight and parallel lines. At other times they appear to traverse the disc in more or less curved paths. By means also of reference to the tables of measurement of solar diameters in the *Nautical Almanack* for every day of the year, the amount of celestial arc expressed by each division of the mother-of-pearl may be very approximately obtained by observing how many of them occupy the diameter of the solar disc, and dividing the total number of seconds contained in a solar diameter thereby.

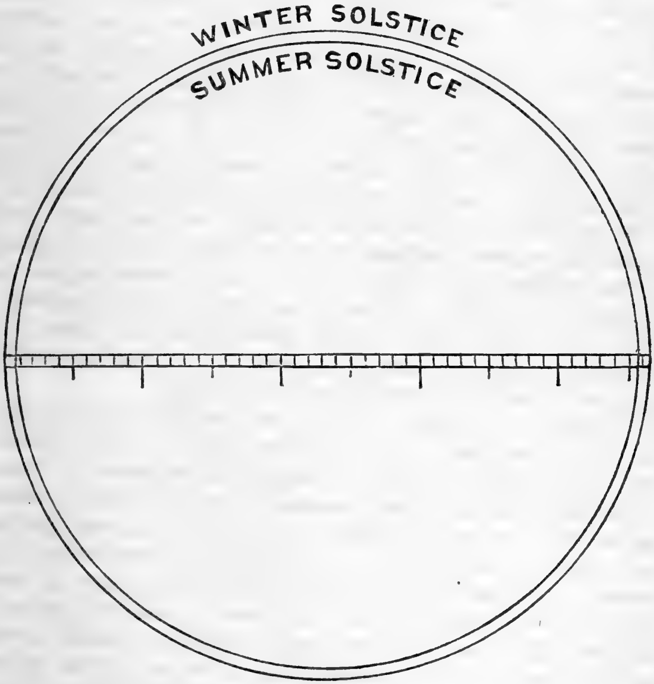
The writer finds that, with his achromatic of about three inches aperture, and with a terrestrial eye-piece, magnifying thirty times linear, each graduation subtends just about $42\frac{1}{3}$ seconds of celestial arc; and that at the period of aphelion, or our summer solstice, just 45 of them may be seen to span the solar diameter; whilst at perihelion, or our winter solstice, $46\frac{1}{4}$ of them are required.

The difference, which is very palpable, is shown in the cut.

We will now give a brief description of the phenomena

which commonly attend the life-history of a group of solar spots—observing, in passing, that usually they burst out more rapidly than they subside. Their formation commences generally with the appearance in the photosphere of one or more small specks, of only a few seconds in diameter, which sometimes are penumbral (grey) in their tint, and sometimes umbral, or blackish; implying consequently a greater or less amount of profundity—the deeper the blacker.

This stage is not shown in the Plate, because, in fact, the group had passed through it previously to its appearance upon the disc, which revolves, be it remembered, upon an axis, in



about twenty-five days. Fig. 1 was drawn when the leading spot of the group had advanced about $3\frac{1}{2}$ minutes from the sun's limb or margin, and which would therefore be on the third day after its first entrance upon the visible disc. At this time several bright streaks of faculæ lay to the *left* of the group, which from some cause or other is usually the side they are wont to affect; though this rule is by no means invariable, for the faculæ frequently lie closely round the outer edge of a spot, and sometimes they may be seen scattered to the right as well as the left of a group.

At this stage of the formation of the group (Fig. 1) it may be observed how the umbræ or darker parts lie on the inner side of the penumbræ or lighter parts—a circumstance this which is highly characteristic of a group of spots, especially the more subordinate outlying ones, and also in its earlier stages, however it is to be accounted for, though it would seem to result from forces acting either from the centre, towards the circumference of the disturbed area, or *vice versâ*. At this time the total portion of the photosphere displaced by the various spots composing this group amounted to upwards of 400,000,000 square miles—an enormous area, indeed, as compared with aught terrestrial, but still far less extensive than is often the case on the surface of the mighty sun. Indeed, within twenty-one hours after Fig. 1 was drawn, the displacement of photosphere had reached about 778,000,000 square miles (see Fig. 2), and the group even then was not fully developed, which occurrence took place on Jan. 26, and when the whole area of this group (and there were others on the sun at the time) amounted to the enormous sum of 1,545,000,000 square miles, or about eight times the superficies of the terraqueous globe! The writer has, however, observed them even larger than this. But to return to our group as it appears in Fig. 2. The umbra of the principal spot (which is almost invariably the preceding one in the order of their advance across the disc) was now well surrounded by penumbra on all sides, and it moreover consisted of matter of two distinct tints—each, however, much darker than the penumbra—and the lighter of which two constituted the umbra, and the darkest and deepest the nuclei, of which there were two or three. The way in which the penumbra is usually marked with streaks, radiating, as it were, from the umbra, is now very apparent; indicating a current of some sort setting in, either the circumference to the centre, or from the centre to the circumference, and perhaps also either a down-rush or an up-rush of gaseous matter. That it was a down-rush on the present occasion seems strongly indicated by a phenomenon to which attention is directed by the writer in vol. xxvii., p. 185, of the *Monthly Notices* of the Royal Astronomical Society. He began to make a drawing of this spot at 11 a.m., Jan. 25, and observed at that time a small patch, of an almost umbral tint, at the upper edge of the penumbra (this patch may be seen in Fig. 2). He drew it, as it then appeared, exactly on the margin. But by the time he had finished the spot, as well as others on the disc, upon looking over his work, he found that the small patch was no longer at the margin. Believing he must have blundered, he altered it; but in an hour or so afterwards he observed that it was conspicuously removed from

the edge of the penumbra. He watched it for another hour, when his impressions were put beyond a doubt, and he called in a friend, a good observer, to corroborate the observation. Both himself and companion saw that the patch was distinctly drawing rapidly in towards the central umbra, and by three o'clock in the afternoon it had advanced two-thirds of the distance ($=12''$) between the margin of the penumbra and the umbra, at the same time becoming more condensed and elongated in the direction of the usual striations on the penumbra.*

Fig. 3 shows the spot as it appeared about noon on January 28th. It was now beginning to diminish in area from what it was on the 26th, and the subordinate spots of the group were also beginning to break up; the photosphere, in other words, was beginning to re-assume its ascendancy; a sort of cicatrizing process, if we may so say, was setting in.

The spot was now, however, and had for three days previously been interesting, from the presence of a well-defined but ragged promontory or bridge, which floated over the umbra and divided it into different portions, as may so often be observed in the solar spots. At this time the promontory was not more luminous than the general penumbra to which it was attached, and it was consequently, in all probability floating at about the same level with it, and of the same temperature.

But on January 29th (see Fig. 4), not only had the promontory greatly altered in shape, but it was now as bright as the photosphere itself, with which indeed it seemed now in direct communication, by means of luminous streaks of considerable width, with which the penumbra had been invaded, showing either that the promontory of the previous day had risen up to the level of the photosphere and become equally luminous with it, or that it had sunk down altogether and melted away (as the writer and others have observed them to do), and that its position had been occupied in part by an indraught apparently of luminous matter from the vast circumambient ocean of photosphere. However this may have been, on January 30th the penumbra had again in turn inclosed and isolated the luminous matter in question; though it did not permanently hold it a prisoner; for by January 31st the photosphere had so energetically invaded the principal spot from both sides, as to completely divide it into two spots.

In short, the battle of the solar elements was decided; and on February 1st (the last time the writer was enabled to see the group), the spots were still further dispersing and diminishing; and had utterly disbanded themselves, and disappeared, ere

* In the Plate these striations are rendered somewhat too distinctly.

that portion of the sun by his rotation above alluded to, had again come round upon the disc.

But, finally, what are the sun spots—what the faculæ—what the photosphere—what, in short, as Mr. Carrington asks, is a sun? A congeries of difficulties to grapple with! But let us hope that by means of the rapid march of science in the departments of chemistry, electricity, spectrum analysis, and what not, the time is not far distant when many of these difficulties will be solved.

Much depends upon our being able satisfactorily to demonstrate (which seems more and more probable) that the laws which govern terrestrial phenomena are the same as those which prevail upon and within our great central luminary, modified very possibly by the existence of conditions, and even perhaps chemical elements peculiar to himself, as the source and dispenser of light, heat, and life, to the planetary worlds around him.

This, at least, seems certain—viz., that the solar spots are *negative* and not *positive*, if we may so say, in their character. That is, that they are areas on the solar surface, where either the photospheric matter has been swept aside, or where it has subsided and become invisible through a change in its temperature and molecular condition; and not actually dark, intervening clouds of condensed, metallic, or other vapour, obscuring simply the subjacent photosphere, as Kirchhoff would have it. Still less we maintain are they (as other theorizers rather than actual observers maintain), scoria, or other hardened masses, capable of being rent asunder, and thus again disclosing the photosphere below, in the shape of loops, bridges, or promontories.

The minute and careful observations multiplied by Nasmyth, Dawes, De La Rue, Lockyer, Chacornac, and the writer, place all such theories out of the question. It is far more probable, if not indeed certain, that the bridges, promontories, and specks of more or less brilliant matter, which all the above observers have distinctly seen to traverse the umbræ and even nuclei of solar spots, have either drifted away from the general mass of the surrounding photosphere, or are sometimes portions of photosphere which have only newly condensed and become visible; other pre-existing portions having, on the other hand, in their turn been seen to subside, apparently, or at any rate to dissolve and melt out of sight; and thus that the matter composing the photosphere may be visible or invisible, according as it is in the solid, liquid, or gaseous condition.

Professor Brayley considers it probable that in the photosphere, and probably the regions and strata lying below it, solid matter must be continually being produced, dissolved, and

reproduced by some such alternate process of refrigeration, breaking-up, and subsidence; and that it is from this more solid matter that the solar radiation of light and heat mainly proceeds. "An incandescent liquid or gas," as the President of the Royal Astronomical Society, too, observes, "such as we suppose the sun's atmosphere to consist of, will not give out light. We want, therefore, something floating in it, or where could the light come from?"

While on this subject of crystallization and subsidence, the writer would here state how, on more than one occasion, he has been reminded of such a state of things by a curious and interesting (if *not* very analogous) phenomenon presented to view in the boiling salt-pans at Droitwich in Worcestershire. The crystals of salt, varying much in form and size according to the temperature of the liquor out of which they are produced, first form on the surface of the hot brine, and then, after a while, begin to subside in patches not very unlike solar spots, or groups of spots. Other portions of the yet floating crust of salt may frequently be seen marked with bright blotches and reticulations, more nearly resembling solar faculæ, so far as mere form is concerned, than any other object he could readily call to mind. It is not, however, here intended that we are to consider the sun as a merely vast mineral salt bath; though sodium, at any rate, appears to be present there in sufficient abundance; and the mean density of his mass is just about the same as that of the brine!

A curious theory of the origin of solar spots, at present in increasing favour with some of our most philosophical observers* is, that they are produced by external planetary influences. Every twenty months or so, as they observe, the spots seem to assume the same sort of behaviour in their manner of forming and disappearing. With this circumstance is to be coupled the fact that every twenty months the planet Venus returns to the same position with reference to the earth, and that then, too, we see that, as any portion of the sun's surface retreats from the neighbourhood of Venus, the solar spots on that portion have a tendency to increase, attaining a maximum at the point furthest from Venus. And the inference they draw from this curious phenomenon—backed up by certain physical experiments in connection with heat, light, electricity, vaporization, pressure, etc., is that the sun is probably in such a sensitive molecular condition that its mass may experience wonderful changes from very small outward influences.

Now that the continuity of the outermost strata of the sun is, from some cause or other, subject to the most astonishingly extensive, and often rapid changes, is certain enough; as may

* Messrs. De La Rue, Balfour Stewart, Loewy, and others.

be sufficiently seen from the changes undergone in twenty-one hours in the group represented in Figs. 1 and 2 in the Plate. And the writer has often expressed his opinion that, along, perhaps, with other allied agencies, these changes are in some way connected with alterations in the magnetic conditions of the solar photosphere—an opinion with which the theory of planetary configurations and influences is quite in harmony; as also may be many other forces believed to be in operation on the solar surface, and probably also within the interior mass likewise.

In many respects, lastly, the forces they exhibit are as mighty in their operation as they are mysterious in their origin. We cannot doubt that, on the whole, they are necessary and beneficial to the several worlds which constitute the dominion of the sun; though they are occult and hidden in their nature; and may very possibly at times, and at the ordering of the Most High, rule over conditions of plague and scarcity, as well as of health and prosperity; for these circumstances, we can scarcely doubt, are in intimate connection with those terrestrial, magnetic, and atmospheric conditions over which the sun has been bidden to exercise his vast and ever-varying, and, generally, benignant influences.

VEGETABLE MONSTROSITIES AND RACES.

BY CH. NAUDIN.

(*From Comptes Rendus.*)

The discussion recently excited by MM. Dareste and Sanson, as to whether monstrosities in the animal kingdom can give rise to distinct races, recalls to my mind teratological facts, which appear to demonstrate that this may be the case in the vegetable world.

To avoid doubt, it may be well to explain that I use the word *monstrosity* in its ordinary botanical sense, that of notable departure from forms, that are typical, or reputed to be such. There is a marked distinction between monstrosities incompatible with reproduction, and those which do not impair the reproductive faculty. It is of the last only I have now to speak.

Well attested facts seem to me to place beyond doubt that considerable anomalies in the vegetable kingdom, that are usually classed amongst teratological facts, are faithfully transmitted from one generation to another, and become the

salient characters of new races. Horticultural practice might have furnished a great number of such instances if they had been collected, and verified by experiment; but I shall only cite a few, because they are the only ones which I know to have been examined scientifically, and they suffice to establish the principle of hereditary transmission of anamolies, by sexual propagation through an indefinite series of generations.

The first fact of this sort shall be borrowed from Professor Göppert, of Breslau. A poppy exhibited the curious anomaly of the transformation of part of its stamens into carpels, from whence resulted a crown of secondary capsules round the normal and central capsule, whose development was complete. Many of the little additional capsules contained, as well as the normal capsule, perfect seeds, capable of reproducing the plant. In 1849, Professor Göppert, hearing that a field of these monstrous poppies existed a few miles from Breslau, caused to be sown in the following year a considerable quantity of seed taken designedly from the normal capsules, and almost all the plants springing from this seed exhibited to a greater or less extent the monstrosity of the preceding generation. I do not insist upon these facts, because observation of them was not carried to a sufficient extent, and it might be found that the number of generations was not large enough to conclude from them the stability of the anomaly.

This doubt does not affect the following case:—Cultivators of ferns know that these plants are very subject to variation, and that some of them exhibit, even in a wild state, veritable monstrosities in the conformation of their leaves. These monstrosities are much sought after by collectors, and are regarded as excellencies, for which a high price was paid. Now they are easily and abundantly procured by simply growing spores taken from the abnormal part of a fertile frond. When the frond has remained in a normal state, the spores give rise to normal plants, while those from monstrous parts of the same frond are sure to produce plants affected by same kinds of change. During many years that this method of propagation has been employed, the transmission of the monstrosity has not been contradicted by experience.

Very considerable anomalies, which even more than those just cited, may be called monstrosities, are observed in three species of edible gourds, plants which have been cultivated from time immemorial, and which have never been found in a wild state. These anomalies have the peculiarity of characterising races that are sharply divided and very persistent, and which maintain themselves, in spite of change of locality and climate, and partially resist crossing with other races of the same species. The date of their origin is unknown, and we

cannot now tell under what influences they were formed; but as the species are all domestic, it is probable that some, if not all, have been produced by cultivation. Among them is a race of common gourds (*Cucurbita pepo*), in which the tendrils convert themselves into a sort of branches bearing leaves, flowers, and often fruits. There are also numerous races of the same species producing deformed fruits, warty, and parti-coloured, and which transmit their peculiarities with their seed so long as they are not modified by crossing.

A still more remarkable example is afforded by a small race of pumpkins, *C. maxima*, which we have received from China, and observed for many years in the Museum. It differs from the typical form of the species by the ovary, and the fruit being entirely free, and the tube of the calyx being reduced to a sort of disk (*plateau*), serving for the support of the carpels; notwithstanding, the complete adhesion of the ovary to the tube of the calyx is stated by authors to be an essential character of the family of the Cucurbitaceæ. This example shows how great the extent of variation may be, and what fixity they may acquire when once produced.

The next fact of which I have to speak is quite recent, and has already been brought before the Academy by Dr. Godron, Professor of Botany, at Nancy. In 1861 M. Godron found, in a crop of *Datura tatula*, a species with very spiny fruit, a single individual, in which the capsule was perfectly smooth, and unarmed. Seeds taken from this capsule gave, in 1862, a batch of plants, all of which reproduced the peculiarities of the individual from which they sprung. From their seed grew a third generation, similarly smooth, and in 1865 and 1866 I saw at the Museum the fourth and fifth generation of this new race, in all more than 100 individuals, not one of which manifested the least tendency to reproduce the spinous character of the species. Crossed with this last by M. Godron himself, the unarmed race produced mule plants, which in the succeeding generation returned to the spiny form, and the unarmed form, being, in fact, genuine hybrids, endowed with fertility. M. Godron, from these facts, refers to one species, the *Datura Stramonium*, *D. lævis* (of Bertoloni, not of Linnæus), and *D. Tatula*, three constant forms previously regarded as good species, and adding to it *D. Tatula-inermis*, discovered by himself, and so to speak, born under his eyes. These four distinct forms have arisen by variation from a single type, not one of them wanting in any character assignable to true species.

Here a point presents itself, to which I would call the attention of all who believe in the mutability of specific forms, and who attribute the origin of actual species to simple modifica-

tions of more ancient species. Most of these observers admit that such modifications have been produced with exceeding slowness through insensible gradations, so that thousands of generations may have been required to transform one species into a neighbouring species. We know not what may have happened in the course of ages; but experience and observation teach us that at the actual epoch of anomalies, whether slight or profound, the alterations in what we, perhaps, arbitrarily, call *specific types*—the *monstrosities*, in fact, whether they are of a transitory and individual character, or whether they give rise to new races, persistent and uniform, through an indefinite number of individuals—are produced abruptly; and without any transitive forms between them and the normal form. A new race is born completely formed, and the first individual representing it exhibits the characters of the generations that will succeed if the variation is preserved. New modifications may be added to the first one, and occasion a subdivision into primary and secondary races; but these appear with the same suddenness as the first variation did. I am not defending the doctrine of evolution. I state merely that the biological phenomenon of one epoch do not justify, in any way, the hypothesis of an insensible degradation of ancient forms, and the necessity for millions of years in order to change the physiognomy of species. Judging from what we know, their transformations, if they have taken place, may have been effected in a much smaller lapse of time than is supposed. There may be alternations in the life of nature, and periods of immobility, apparent or real, may succeed other periods of rapid transformation, during which that which was previously exceptional and abnormal, becomes a portion of the regular order of things. And we must not forget that time is to us a succession of phenomena, and that whether the phenomena succeed each other quickly or slowly, it is all one for the doctrine of evolution. In either case the principle of continuity is not assailed.

ANCIENT MEN IN WIRTEMBERG.

The following paper is taken from the *Archives des Sciences.* It gives an account of recent discoveries of the remains of human industry in Wirtemberg as described by Professor Fraas.

In 1866, a mason of Schussenried, in Wirtemberg, was obliged to dig a long and deep channel to carry off some water that had been diverted by the drainage of an adjacent swamp. This work led to the discovery of a large quantity of fragments of bone and reindeer horn, and of implements wrought in flint and bone. Dr. Fraas had special diggings made to explore this deposit, and examined the results with great care. The ground cut through in these diggings showed the following succession, beginning at the bottom—a bed of erratic gravel, a layer of tuff containing terrestrial and fluviatile shells, identical with living species, and lastly, a thick bed of turf, forming the existing surface. The bones and wrought objects were discovered in a sort of excavation, or pocket, dug in the gravel and filled with moss and sand. The moss, which formed a thick layer between the gravel and the tuff, was in a state of such perfect preservation, that the species could be exactly determined by M. Schimper. They were *Hypnum sarmentosum* (Wahl.), *Hypnum aduncum*, var. *Grœnlandicum* (Hedwig), and *Hypnum fluitans*, var. *tenuissimum*. These mosses now live either in high latitudes or at considerable elevations above the sea-level, usually near the snow, or the nearly frozen water running from it. They belong to a very northern flora—about 70°,—and the *Hypnum sarmentosum*, in particular, to the limits of perpetual snow. The lower gravel is evidently erratic, and the marshy plain which the cutting traverses rests against a gravel-hill, which is nothing but an ancient moraine, and M. Desor states that in the vicinity of glaciers, hollows are found similar to this one containing various objects, and believed by Dr. Fraas to have been the rubbish hole of an ancient people, living at the time when the reindeer inhabited the neighbourhood.

All the bones found in the moss, which is kept wet by numerous springs, are completely preserved, while those in the gravel are entirely decomposed. The recent diggings exposed a prodigious quantity of bones and reindeer horns. The bones are all broken, having been split to extract their marrow; the horns were in great number, some whole, and belonging to young animals, others had been put to divers uses, and rejected as worn out. It is curious that the teeth had been carefully extracted from the jaws, for what purpose is un-

known. Except some fragments belonging to a species of ox, no bones of other ruminants were found, but there were some remains of the horse. The presence of the glutton, of a bear, differing from that of the caverns, and resembling the arctic bear, of the wolf, the polar fox, and the swan, and the absence of the dog, appears made out.

The fauna, like the flora, thus testifies to a northern climate, being composed of animals not fearing cold, and presenting no trace of that mixture observed elsewhere of northern animals with others belonging to temperate or southern regions. The remains of human industry consist principally of wrought flints (600 pieces), lance-points, arrow-heads, etc.; (no hatchets) some blocks (*nucléus*), together with needles, hooks, etc., of reindeer horn. Besides these, some rolled flints had evidently been used as hammers. Some flat stones, bearing traces of fire, and bits of charcoal testified also to the presence of man. There was no trace of pottery, nor of human bones. Nothing good, nothing whole, was thrown into this ditch; it was simply a receptacle for rubbish.

The fauna and the flora had, as we have seen, a peculiarly northern character; much more so than those of other stations of the reindeer epoch—that of Languedoc, for example. This remarkable fact gives importance to the discovery of Dr. Fraas. Must we conclude from it that the station of Schussenried belonged to a more ancient period? This is probable, but requires to be confirmed by further investigation. We must notice the apparent inferior civilization of the people to whom these relics belonged. They do not seem to have been acquainted with the potter's art, nor to have ornamented their implements with any sculpture.

Evidently, the station of Schussenried was posterior to the glacial epoch, properly so called—that is to say, to the time when the glacier of the Rhine formed moraines and accumulated gravels. But we may conclude from the presence of northern mosses, and from the character of the fauna, that the country had not been long cleared of ice when the people, who left these traces, established themselves in it. It is probable that fresh researches at other points may lead to the discovery of new stations, and fresh means of comparison, which may enable the age of that of Schussenried to be fixed.

MR. GRAHAM'S RECENT DISCOVERIES: — THE ABSORPTION AND DIALYTIC SEPARATION OF GASES BY COLLOID SEPTA:—THE OCCLUSION OF GASES.

In a series of papers communicated to the Royal Society, Mr. Graham has detailed his beautiful researches into the diffusion of gases. The subject of this paper is a brief account of his recent researches on the Absorption and Dialytic Separation of Gases by Colloid Septa.

It is necessary to remember that all gases when existing under circumstances in which they do not chemically combine, yet diffuse themselves through one another and form a uniform mixture, even though their specific gravities may be widely different, and they be kept externally at perfect rest; the law being that this tendency to diffuse varies in the inverse ratio of the square roots of their specific gravities. It must also be borne in mind that the same law regulates the diffusion of gases through septa possessing minute pores as when the gases communicate freely with each other.

Mr. Graham has shown how a mixture of gases may be changed in composition by the escape of the lighter and, therefore, more diffusible gas, this fact being well shown by passing an explosive mixture of one volume of oxygen and two volumes of hydrogen through the stem of a tobacco-pipe enclosed in an outer tube of glass, which is rendered vacuous, the hydrogen being more diffusive, streams through the porous walls so much faster than the oxygen that on issuing from the end of the pipe the mixture ceases to be explosive. But mixed gases must differ considerably in specific gravity in order to separate from one another to any great extent in their molecular passage into vacuum.

In his recent researches Mr. Graham has employed—firstly, the soft colloid, india-rubber; secondly, those metals to which a certain degree of colloid property might be imparted by means of heat.

When atmospheric air is separated from a vacuous space by a septum, or bag of india-rubber, some air passes through it into the vacuum. In observing the passage of air and gases into vacuum, the Torricellian vacuum was first employed. A plain glass tube, two millimetres in diameter and one metre in length, is closed at one end by a sheet of thin india-rubber strained over a porous plug of plaster of Paris, the tube is now filled with mercury and inverted, a vacuum being obtained into which air (or any gas allowed to play upon the disk of rubber) gradually penetrates, passing through the film and depressing the mercurial column in the

tube. The following numbers represent the velocity with which the rubber is penetrated by different gases in equal times :—

Nitrogen	1
Carbonic oxide	1·113
Atmospheric air	1·149
Marsh gas	2·148
Oxygen	2·55
Hydrogen	5·50
Carbonic acid	13·58

Air being a mechanical mixture of 21 per cent. of oxygen and 79 per cent. of nitrogen, the constituents of atmospheric air are carried through a film of rubber into a vacuum nearly in the same relative proportion as the same gases penetrate it singly, hence the composition of air "dialyzed" by the india-rubber septum is deducible by calculation—

Oxygen .	21	×	2·556	=	53·676	=	40·46
Nitrogen .	79	×	1	=	79·	=	59·54
							100·00

In the experiment with the Torricellian vacuum, air entering through the rubber was found to have the composition indicated by theory—40 per cent. oxygen and 60 per cent. nitrogen.

Dr. Sprengel's Mercurial Exhauster (Fig. 1) is now used instead of the Torricellian vacuum. It possesses the advantage of simultaneously maintaining the space vacuous, and delivering for examination any air entering through the septum.

The flow of mercury, from the funnel, A, through the fall tube, C B, is regulated by the clip which compresses the caoutchouc tube, C. The receiver to be exhausted is connected with the fall tube by a branch arm, X.

The descending stream of mercury draws the air

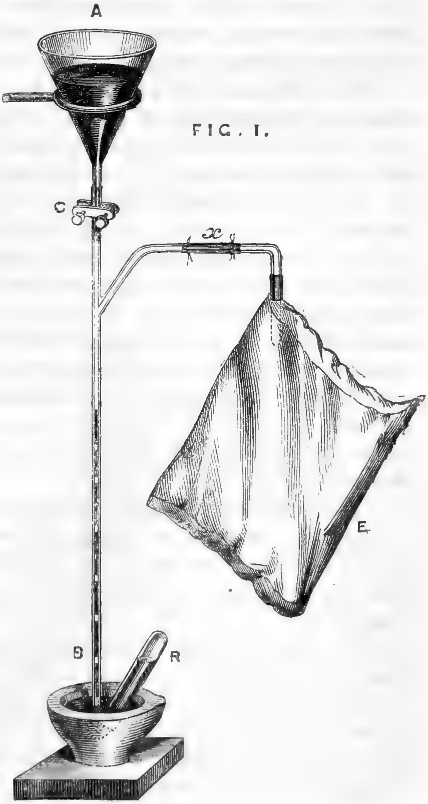


FIG. I.

from the receiver and delivers it at R, a vacuum being ultimately produced.

E represents a bag of silk, varnished with india-rubber, lined with felted carpet.

After allowing sufficient time for the removal of the original air (representing the capacity of the bag), it will be found that the air *penetrating* the bag, and delivered into the tube, R, possesses the power of rekindling a glowing splinter of wood; analysis proving it to contain 40 per cent. of oxygen and 60 of nitrogen.

The constituents of atmospheric air will also pass through rubber into a space containing some other gas, as hydrogen or carbonic acid, at the same relative velocities with which they enter a vacuous space. Later experiments have also proved that air may be changed in composition by escaping under a pressure of two atmospheres through a rubber septum, the proportion of oxygen transmitted being slightly less than in the experiments with the vacuum.

This penetration of india-rubber by gases is not due to diffusion through actual pores; if it were, the lighter gases would pass through with the greater velocity; in the experiment with the rubber film, or bag, for instance, diffusion would favour the passage of nitrogen.

It will be seen, from the table given on page 453, that those gases which penetrate the rubber most readily are those most easily liquified by pressure, and also generally highly soluble in water.

Mr. Graham considers that the penetration of the gas through rubber is due to its previous absorption as a liquid in the soft, colloid substance of the india-rubber, the transmission being effected by the agency of *liquid*, and not gaseous diffusion. The rubber being wetted through by the liquified gas, the latter evaporates, and reappears on the other side of the membrane as a true gas.

There is, moreover, experimental proof of this *absorption*. When india-rubber is exposed to an atmosphere of carbonic acid gas, it takes up in one hour nearly its own volume, and this gas may be subsequently extracted by the action of the vacuum. Oxygen is twice as *soluble* in india-rubber as in water, and two and a half times more soluble in rubber than nitrogen is.

These experiments are of great physiological interest. Respiration is probably due to the liquid diffusion of gases through membranes. The air-bladder of fishes, especially those without a pneumatic duct, must be filled by the same agency.

In extending the inquiry to the passage of gases through metals, Mr. Graham employed tubes closed at one end, the

open end being placed in connection with Sprengel's Mercurial Exhauster. The metallic tubes were placed within porcelain tubes; the gas under examination was allowed to circulate through the annular space between the two, and the arrangement admitted the subsequent application of heat.

With a platinum tube, and *air* circulating outside it, the vacuum remained undisturbed, even when the temperature rose to a bright red heat: but when dry *hydrogen* was made to pass through the annular space, the platinum allowed the hydrogen to pass through into the vacuum, as soon as, but not until, the metal was raised to a red heat. In seven minutes the Sprengel tube delivered 15·47 cubic centimetres of gas, of which 15·27 cubic centimetres were pure hydrogen. The platinum tube employed was 1·1 millimetre in thickness, with an internal diameter of 12 millimetres.

The surface actually heated was 200 millimetres (8 inches). The rate of passage of the hydrogen was therefore 489·2 cubic centimetres, through a *square metre* of platinum 1·1 millimetres thick in one minute. The passage of other gases through the same tube was next examined, the experiments being conducted in exactly the same way, the metal being heated to bright redness. The most interesting fact developed itself, that while hydrogen could penetrate at the above rate, the following gases were incapable of passing, even to the extent of 0·2 cubic centimetres in one hour:—Oxygen, nitrogen, chlorine, hydrochloric acid, steam, carbonic acid, carbonic oxide, marsh gas, olefiant gas, hydrosulphuric acid, and ammonia.

It was, however, with a tube of palladium that the most remarkable results were obtained, that metal permitting the permeation of hydrogen with far greater facility than platinum, and at a temperature short of redness. The closed palladium tube remained perfectly tight when connected with the Mercurial Exhauster, with air (or carbonic acid) outside the tube, both at the ordinary temperature, and at a temperature near low redness.

When dry hydrogen was allowed to circulate in the annular space, none passed through in three hours at a temperature of 100° C., but when the temperature was raised to 240° C., the hydrogen began to come through at a gradually increasing rate, until 265° C. was reached, when the exhauster delivered 11·2 cubic centimetres in five minutes, or 423 cubic centimetres for a *square metre* of palladium one millimetre thick.

It is interesting to compare the passage of hydrogen through the palladium with the penetration of the same gas into vacuum through a septum of india-rubber. The palladium, one millimetre in thickness, was seventy times the thickness of the rubber sheet.

The comparison follows, penetration of hydrogen through a square metre of the rubber in one minute, at a temperature of 20° C.=127 cubic centimetres, through the palladium=423 cubic centimetres, at a temperature of 265° C.

It has been shown that oxygen could be partially separated from atmospheric air by the septum of india-rubber, while platinum and palladium only permit hydrogen to pass, apparently to the exclusion of every other gas. Therefore when the palladium tube was heated to 270° C. in an atmosphere of coal gas consisting of a mixture of 45 per cent. marsh gas, with 40 per cent. free hydrogen, the gas penetrating the metal and delivered by the mercurial exhauster contained no trace of carbon compound, but was *pure hydrogen.*

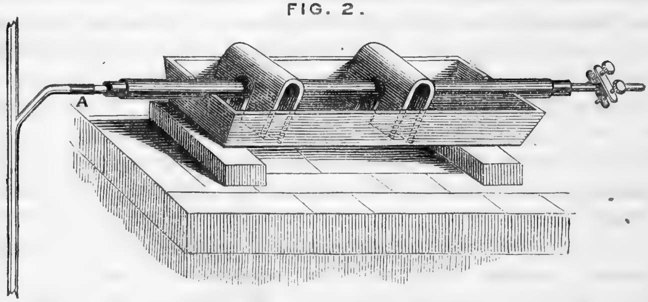
It is now necessary to consider the nature of these transmissions in the case of the rubber and metal respectively.

In the passage of gas through the india-rubber, it has been shown that the colloid substance possessed the power of absorbing the gas. Is the penetration of the platinum due to the same cause ?

The following experiments were devised in order to determine this :—

The metal was first carefully cleaned by washing in alkali, and subsequently with distilled water ; it was then introduced into a porcelain tube glazed both inside and out, and provided with corks well covered with fused gutta percha, each cork was fitted with a fine quill tube. The one quill tube, A, being connected with the mercurial exhauster, the other being then closed. It is evident, therefore, that the apparatus afforded a means of heating the metal in vacuo, and of transferring any gas that might be distilled over.

FIG. 2.



Wire of fused platinum weighing 200 grammes was heated to bright redness, and allowed to cool slowly in a stream of pure and dry hydrogen.

The same wire on distillation in vacuo gave 2·12 cubic

centimetres of gas, of which 1·93 proved to be pure hydrogen.

The weight of the metal being divided by its specific gravity (201÷21·5) gives the volume of the metal=9·34 cubic centimetres; hence the one volume of platinum held (the gas being measured cold), 0·207 volumes of hydrogen. It must be admitted, therefore, that platinum has a power to absorb hydrogen at a red heat, and to retain it for an indefinite period, to this power Mr. Graham has given the name of *occlusion* (a shutting up) of hydrogen by the metal.

Hammered platinum has a much higher absorbing or "occluding" power than the fused metal, probably owing to a mechanical difference in the texture, a specimen, in the form of tube, occluded 2·8 times its volume of hydrogen; the same platinum again charged with hydrogen was sealed up in a glass tube, after two months it gave on distillation in vacuo 2·28 times its volume of gas, tending to prove that the hydrogen had been retained by the platinum without loss.

It has already been stated that the transmission of hydrogen through palladium was far more striking than in the case of platinum, the permeation taking place at a far lower temperature. The results given by the occlusion of hydrogen by this metal were also most remarkable. A specimen of foil rolled from wrought palladium, weighing 1·58 grammes, was exposed to hydrogen, at a temperature between 90° and 78° C. for three hours, and then allowed to cool slowly in a stream of the gas. The metal was then transferred to a glass tube, which was exhausted in the usual way, and on being heated with a gas flame the palladium gave off gas in a continuous stream for twelve minutes, when the evolution ceased. The volume of gas amounted to 85·56 cubic centimetres. The palladium having occluded 643·3 times its volume of hydrogen. As in the case of the platinum the *melted* metal does not possess the power to the same degree as the wrought metal. The specimen examined absorbed about 347 times its volume of hydrogen.

Each metal exerts a selective power for gases. Copper wire occludes 0.306 times its volume of hydrogen. Gold cornets* from the refuse of assays were examined without preliminary treatment, 93 grammes, having a volume of 4.83 cubic centimetres, gave, on heating in vacuo, 10.25 cubic centimetres of gas, which consisted principally of carbonic oxide. The same cornets, though they never assumed so much gas as they acquired in the muffle, still occluded 0.33 times their volume of carbonic oxide, and 0.48 times their volume of hydrogen.

* When the button of gold is removed from the assay furnace it is rolled into a riband and twisted into a flat spiral, to which the name of "cornet" is given.

Heated in air they absorbed 0.2 times their volume of gas, which was principally nitrogen, showing a remarkable indifference to oxygen. Silver was also examined, one specimen occluded in successive experiments 8.05 and 7.47 times its volume of oxygen, without any visible tarnish.

It was with iron that results of the greatest commercial, as well as scientific interest, were obtained. Iron possesses the power to occlude hydrogen, but carbonic oxide is taken up far more largely than hydrogen, by slowly cooling the metal, from a dull red heat. In the process of converting iron into steel by cementation, the bars of malleable iron are imbedded in charcoal, and heated to redness in chests of fire-brick. The cause of the penetration of carbon into the centre of the mass of iron has always been obscure.

As Mr. Graham observes, the occlusion of carbonic oxide by the metal at a low red heat appears to be the first and necessary step in the process of "acieration." The gas appears to abandon half its carbon to the iron, when the temperature is afterwards raised to a considerably higher degree. The process of cementation being thus divided into two distinct stages, the first at a low temperature, during which the carbonic oxide is occluded, the second at a higher temperature, in which carbon is separated.

Lastly, in all these experiments, the metal was first heated in vacuo, in order to remove any gases that might have been occluded in the process of its manufacture.

The natural gases of commercial wrought iron appear to be a mixture of hydrogen and carbonic oxide. It became, therefore, a point of great interest to examine the natural gases of meteoric iron. A notice of the facts having appeared in a late number, it is only necessary to state that the iron of the Lenarto meteorite gave out on heating in vacuo 2.8 times its volume of gas; of which eighty-five per cent. was hydrogen. Thus a fall of meteoric iron on the earth brings to us the same gas that has been discovered by Messrs. Huggins and Miller to exist in the atmosphere of many of the fixed stars.

CLUSTERS AND NEBULÆ.—SOUTHERN OBJECTS.—DOUBLE STARS.—OCCULTATION.

BY THE REV. T. W. WEBB, A.M., F.R.A.S.

If we suppose a line drawn from *Arcturus* to *α Ophiuchi,* and from near its centre drop a perpendicular to it for some distance, the latter will hit a 2 mag. star, the brightest in a considerable area, *α Serpentis,* which may be also identified from its lying in a straight line between two 3 mag. attendants, the one *n p* being δ (which is double, No. 26 of our list, Int. Obs. ii., 56), the other *s f* (which is nearer *α*) being ϵ. From this last star we must run out a line at something less than a right angle—say 80°—with that joining ϵ and δ, and of about equal length; if we then sweep over the region where it ends, we shall find a 5 mag. star, 5 *Serpentis,* which should be visible to a keen sight, but will at any rate be conspicuous with slight optical aid: just *n p,* the finder will show us a patch of haze, and the telescope will reveal—

44. *The Great Cluster in Libra.* Gen. Cat. 4083—M 5. Smyth calls this a most beautiful cluster of minute stars, greatly compressed in the centre, with outliers in all directions. In his achromatic of $5\frac{9}{10}$ inch aperture it was a superb object, with a bright central blaze, exceeding even M 3 (No. 41 in our last number) in concentration. The progress of optical power is well illustrated by the fact that M., the discoverer, said of it, in 1764, "je me suis assuré qu'elle ne contient aucune étoile," and H with the 40f. reflector, in 1791, counted about 200 in it, though they were undistinguishable from compression in the centre. H. with less aperture, but finer definition, describes it as "a most magnificent, excessively compressed cluster of a globular character. Stars 11—15 mag. Diam. in R.A.=10 sec. of time: the more condensed part projected on [seen through ?] a loose irregular ground of stars. The condensation is progressive up to the centre, where the stars run together into a blaze, or like a snowball; the scattered stars occupy nearly the whole field. The neighbourhood is poor in stars." He has also given a beautiful figure, well exhibiting the general character, especially as to the varying sizes of the stars. With my $9\frac{1}{3}$ inch speculum I found it a very bright and beautiful object, the central body of minute stars being barely resolved, while many larger ones are scattered irregularly around and across, or throughout, the glittering accumulation. I noticed, however, some features which do not appear either in the description or drawing of H. The brightest part of the condensed mass lies decidedly *n p* its general centre of

figure; the largest star in that portion is *s f* the centre; and *n* of the blaze, and beyond a comparatively vacant interval, there is a curved line formed by several of the brighter stars, pointing a little inwards at its *p* extremity, as though it were a portion of a large spiral. These are indeed minutiæ. But such minutiæ not merely form the distinctive character of the object, but may be important in process of time as tests of the stability of a system, of whose real nature we know much less than we infer. It may be to this string of stars that the E. of Rosse alludes, in including the cluster among those in the exterior stars of which "there appears to be a tendency to an arrangement in curved branches, which cannot well be unreal or accidental." Supposing the impression to be as accurate as it is strong, the brighter stars, of which there are many scattered in a surrounding low-power field, are not accidentally projected in front of and around the mass, but form a constituent part of it; and if so, we have evidence of the combination of widely different magnitudes in one system, more distinct than even in the case of M 3, described in our last number. With a power of 450, which for such an object overpresses the light of 9¼ in. of silver-on-glass, it is but a turbid speck. But words cannot express the magnificence of the spectacle could we be transported to the corresponding, or a still less distance, till that "stellar swarm" was expanded into a glittering mass of hundreds of suns of various sizes, occupying a widely extended region of the sky. Such an object would surely force from the least attentive the exclamation which may well be drawn out even by the feeble approximation to such a sight in a competent telescope, "Great and marvellous are Thy works, O Lord God Almighty!"

The boundaries of *Libra* and *Serpens* are strangely tortuous and intermixed in this region; in fact this cluster never should have belonged to the former, and has been boldly thrown out of it by Argelander in his *Uranometria*. It may be worthy of notice that 5 *Serpentis*, the guide-star to the cluster, is marked by him as of 5 mag., while he gives only 6 mag. to 10 *Serpentis*, a star intervening with a southward bearing between it and ϵ, but the two appear to me, with a beautiful field-glass, of the same brightness, as they are also marked in the S. D. U. K. map. The remark acquires value from Argelander's high reputation for accuracy; and the stars may deserve watching.

By way of an instructive comparison with this and similar objects in respect of the varying sizes of the stellar components—a point deserving of more consideration than it has received—we will add Sir John Herschel's account of a glorious cluster in the S. hemisphere. We have another motive in doing this—that of gratifying the laudable anxiety of some of

our colonial friends to become better acquainted with the wonders of their peculiar sky. Our readers at home will readily forgive an occasional addition of this kind to our previous plan, both as respects clusters and nebulæ, and double stars, especially as it is from description alone that the majority of them can ever acquire any idea of the riches of a part of the heavens which never rises in these latitudes; and to those once familiarized by personal observation with a class of objects, the verbal account of others of a similar character is neither uninstructive nor uninteresting. These southern additions will be indicated by Roman instead of Arabic numerals in our lists. We begin, then, with

(i.) *The Great Globular Cluster, ω Centauri.* Gen. Cat. 3531. R.A. xiii. h. 18m. D.S. 46° 35′. Of this H. says, that it is beyond all comparison the richest and largest object of the kind in the heavens. Its diameter (in his $18\frac{1}{4}$ inch mirror) is full 20′, or $\frac{2}{3}$ that of the moon: the stars are literally innumerable, and there must be thousands of them, for it is very conspicuous to the naked eye as a dim cometic-looking star of $4\frac{2}{3}$ to 5 mag.; but as the total area is very considerable (not less than a quarter of a square degree), the same quantity of light concentred in a single point would very probably exceed that of a 3 mag. star. The whole mass, which is by gentlest degrees much brighter in the middle, is clearly resolved into stars; these, on a general view, appeared singularly equal, and distributed with the most exact equality, the condensation being that of a sphere equally filled. On more attentive looking, however, he perceived that there were two sizes among them, 12 and 13 mag., without greater or less, and that the larger stars formed rings like lace-work over the mass. One of these rings, $1\frac{1}{2}$′ in diameter, was so marked as to give the appearance of comparative darkness in the centre, like an oval hole divided into a double opening by a bridge of stars. "Altogether," as H. concludes his description, "this object is truly astonishing;" and his figure well corresponds with these words. It is to be regretted that from its position, though it is above the horizon of Spain, Italy, or Greece, it does not attain a meridian altitude of 10° till we reach the latitude of Damascus. Beyond this limit, however, or, perhaps, even before it is attained, in those pellucid skies, it must begin to exhibit its marvellous aspect. An attempt at allineation on the part of one who has never seen the objects may not unfitly excite a smile, but we will attempt to mark its place by saying that it lies a trifle *s* of a line from *a* through *ζ Lupi*, two very solitary and it may be presumed conspicuous 3 mag. stars nearly on the same parallel, and at about half their distance from the latter.

From a great many occasional inspections of this superb cluster, H. inclined to attribute the appearance of two sizes of stars to "little groups and knots of the smaller size lying so nearly in the same visual line as to run together by the aberrations of the eye and telescope: this explanation of an appearance often noticed in the descriptions of such clusters is corroborated in the present instance by the distribution of these apparently larger stars in rings or mesh-like patterns, chiefly about the centre, where the stars are most crowded." This ingenious supposition does not, however, quite account for the equality in size of the larger stars, which, as necessarily composed of groups varying in number, would, it might be expected, show more variety in brightness also. But however correct it may be in this or other instances, it is evidently not applicable to cases such as we have recently described, M 3, and especially M 5, in which the larger stars occur as frequently among the stragglers, where such coincidences must of necessity be far less common. Computation, or even graphical projection, would show what, on the hypothesis of visual coincidence, ought to be the ratio of increase in such combinations as we approach the centre of the mass: the preliminary assumption of symmetry, whether in equidistant arrangement or progressive condensation, would, of course, be seldom fulfilled; but the effect of irregularities would be limited, and might be allowed for within certain bounds of probability. And by working steadily on in this direction we might approximate more nearly to a true idea of the internal structure.

To those possessed of adequate instruments—to which must be added, a knowledge of the effects of perspective—the investigation of the mode of combination and distribution in these grand and mysterious aggregations may be pointed out as an interesting pursuit. We seem already to be upon the trace of some general laws. H. has taught us to look for larger and ruddier stars in a central position; the Earl of Rosse has pointed out a tendency to curvature in the outlying branches, and the occasional presence of dark rifts or "lanes;" and it may fairly be expected that persevering examination, careful drawing, and systematic comparison of the principal clusters, may lead to the detection of other peculiarities, of some significance it may be, at least, to astronomers as yet unborn. However advanced we may deem ourselves—as we unquestionably are—in some, and those very important respects, in others we must even now be satisfied with laying foundations. The "adhuc plus ultra est" of Kepler will never be out of date. As it has been given to us to raise a noble superstructure on the labours of earlier workers, so we must be content to do in turn the same preliminary office for future generalizers

of collected facts. And where movement is imperceptibly tardy, observation can but wait upon it with corresponding patience. In these matters we have reason to believe, though not to be absolutely confident, that motion is all but imperceptible; but we must recollect what has happened to the primitive belief as to the immobility of the so-called Fixed Stars. Change of place in the collective body, which has already been suspected by great observers, and which would be in harmony with the "proper motions" of unnumbered solitary or binary stars, could only be dealt with in the majority of cases by appropriate methods of measurement; the graduated instruments of observatories would, of course, be always applicable, but perhaps seldom necessary, if Alvan Clark's ingenious, beautiful, and far less costly micrometer for measuring large distances (*Monthly Notices*, xix. 324) were brought into use. The range of this apparatus being about a degree, the cases would not be many in which a cluster could not be compared, both in position and distance, with several surrounding stars; and though such comparisons would be singly of little weight, their precariousness would disappear under a multitude of repetitions, while the employment, where practicable, of several stars in different bearings, would detect any material error arising from proper motion amongst them. But besides this, each cluster possessing sufficiently salient points should be watched for a much more interesting phenomenon—internal change. This is so far less probable than spatial movement, as it is unsupported by any other except the most general analogy; but what, of such things, ought to be pronounced impossible? Some great authorities would not so pronounce it. And some clusters are well enough marked to show it, by the distinctness and individuality, or marked arrangement of their brighter components.

Another noticeable feature in stellar clusters would be difference of colour in different parts. Such a variation is not without an analogy, which, however slight and distant, should no more be neglected in an investigation where we have so little to aid us, than some faint foot-print would be disregarded by the traveller in a pathless desert. Notwithstanding what may at first appear the fortuitous dispersion of colour among insulated stars, I have been led to notice so striking a prevalence of an uniform tint in some regions, as to believe that a general and careful review of the whole heavens, with regard to this point, would be desirable. Not only would this be interesting in regard to possible change, but it might lead to some result as to the mode of distribution; and I have been gratified by observing that the idea is corroborated by the spectrometric researches of Secchi, who has detected a preva-

lence of green light among the stars of Orion. But whatever may become of this attempt at analogy—if such it may be termed—the remark of H., already referred to, as to the frequent occurrence of a ruddy star in the midst of a group or cluster, will be full of additional significance when we compare his account of another ornament of the southern skies, to be inserted here:—

(ii.) *The Great Cluster* 47 *Toucani.* Gen. Cat. 52. R.A. 0h. 18m. D.S. 72° 52′; immediately *p* the *n* part of the *Nubecula Minor.* This, according to H., is "a most glorious globular cluster—a stupendous object," the last outliers of which extend 2m. 16s. in R.A. from the centre. The stars are nearly equal, 12 to 14 mag.; immensely numerous, and compressed in three distinct stages—being first very gradually, next pretty suddenly, and finally very suddenly very much brighter up to a central blaze, 13·5s. (R.A.) in diam., where they seem to run together; and whose colour is ruddy or orange-yellow (in another observation pale pinkish or rose-colour), contrasting evidently with the white light of the rest—a phenomenon of which he had no doubt. A double star, 11 mag., lies *s p* the centre, probably, as he thought, without any connection with the cluster. The mass is completely insulated; after it has left the field, "the ground of the sky is perfectly black throughout the whole breadth of the sweep." H̥ would have seen here the result of a gradual agglomeration by the power of gravity through the lapse of innumerable ages. Whatever may be the value of the speculation, for which he supposed there was ground in *his* visible heavens in the case of M 4, and another cluster in *Ophiuchus* (H̥ VI. 40), the fact, at any rate, ought not to escape notice. We have to remember that the central blaze is not viewed by us separately, but as projected in perspective among a very considerable proportion of exterior components in front of and behind it, and that its peculiar tint must be consequently lowered by the admixture of white; which would not be the case with a single ruddy star in that position. If the great reflector, which has been so often spoken of as in contemplation for Melbourne, is ever carried into effect, it is to be hoped that it will be provided with one of Browning's most powerful spectroscopes, as the E. of Rosse's telescope has recently been. It is possible that the central colour may not be out of the reach of its analysis; at any rate, very curious results may fairly be expected from its employment in these unexplored regions.

We will now return to our own skies, for a task requiring some little patience at the hands of those not possessed of graduated instruments—the "fishing up" of a most curious planetary nebula, discovered by Struve I., and therefore called—

[45.] Σ 5 N(eb.) Gen. Cat. 4234. R.A. xvih. 39m. D.N. 24° 4′. To find this we must identify two guide-stars, β and ϵ *Herculis*. The former will be recognized by the directions in INT. OBS., ii. 56 (under κ *Herc.*); the latter from those for ζ, in INT. OBS., vi. 117, since ϵ is the next 3 mag. star *f* ζ, a little *s*. About one-third of the distance from β to ϵ, but considerably *s* of the joining line, we must sweep—and in this case, to our annoyance, not with the finder, in which the object would not be distinguished from a small star, but with the telescope itself, and not with a very low power, for the same reason. With $3\frac{7}{10}$ in. I found it better seen with 144 than 80; with $5\frac{1}{2}$ in. it was not quite stellar even with a comet-finding power of 30, though it would have been altogether so with a lesser aperture.

The reason of this disadvantage in smaller instruments is worthy of notice. The apparent telescopic diameter of a star, or its *spurious disc*, is enlarged, from the undulatory nature of light, and the interference occasioned by our insulating a portion of it by the telescope, in proportion to the diminution of the aperture. Old Hevel, who claims to have been the first to notice this, employed his discovery in an amusing way. The fact had been previously remarked that the stars had no visible circular discs in the telescope, but appeared as radiating and sparkling points. Galileo and others had rightly divined the cause—the excessive distance, on which magnifying power would produce no sensible effect; and the sagacious Kepler had gone a step further in observing that the stars appeared smaller in proportion to the excellence of the telescope. But Hevel rejoiced in the discovery that by the application in front of the object-glass of a diaphragm of the size of a large pea! (which, he confesses, destroyed the definition of the moon) he could see them as circular discs of a sensible magnitude, varying according to the brightness of the star; which he says anyone else might do who knew how to use his telescope aright. Little did the worthy Bürgermeister imagine that he was intentionally producing, in 1647, what it is now the object of every observer to get rid of as much as possible. In proportion to his contracted aperture he was increasing the effect of interference, and in doing what he could to make the stars look like planets, was making them look especially unlike themselves. Now this enlarging effect will be more conspicuous on stars than other objects, because of their more vivid light: the luminous border, so to speak, added by interference, being much less intense, as Airy has shown, than the interior of the disc, may be strongly perceptible with the native radiance of the stars, when with reflected lunar or planetary light it impairs definition in a less obvious degree. (And thus by the

way we get the incidental result, that though a reflector when compared with an achromatic of equal light, is, under ordinary circumstances, at some disadvantage, from including in its larger aperture more atmospheric confusion, still, when the air is really steady, its optical definition will surpass that of its rival.) In the case, however, of the nebula from which we have been wandering so far, the effect of larger aperture is twofold in producing a greater contrast, diminishing at once the spurious discs of the stars, and enlarging the real diameter of the nebula, whose fainter edges come into view. The object thus to be at length "swept up" is termed by Sm. a small pale blue planetary nebula, diam. 8″. With my smaller instrument it was exactly like a star out of focus, bearing 300 well; with the larger one it was a bright ball with woolly edges; 65 seemed to show its colour best; with 111 it was encompassed with a glow, not so evident with higher or lower powers. Secchi saw it with 1500 as a sparkling group of stars. Schultz at Upsala, with a 9½ (Paris ?) in. achromatic, has since described it as a very curious object, 9″·6 diam., almost planetary, yet distinctly granulated; it would, he remarked, be an interesting object for Huggins's analysis; and so it has proved. With 8-in. and powers up to 1000, that observer found it had an uniform disc, intensely bright, and decidedly blue, surrounded with a faint nebulous halo; the spectroscope showed three bright lines, with glimpses of a very faint continuous spectrum: as to the greater part, therefore, of its extent, and possibly with slight condensation in some places, this is a ball of incandescent gas, magnitude and distance utterly unknown!

DOUBLE STARS.

Having learned to find the guide-star to M 5, we should examine it in its individual character, as it is really a pretty pair. It will stand in our list as

160. 5 *Serpentis.* 10″·3. 39°·8. 5½, 10½. Pale yellow, light grey.

We will also include, for another reason,

161. *α Serpentis.* 50″. 1°·5. 2½, 15. Pale yellow, fine blue. The attendant, which is called extremely delicate by Sm., forms an excellent test for light, alike from minuteness, distance, and position. With my 9¼ in. speculum it was quite obvious. I do not, however, profess to be able, in general, to detect any colour in these faint points, which were considered by Σ also, if below *his* 9 m. (=9¾ Sm.) to show no certain hue. In achromatics, if near enough to the larger star, they might, perhaps, acquire an adventitious tint from being involved in its outstanding fringe, the freedom from which constitutes one

great advantage of the reflecting telescope. The light of the silvered mirrors is not indeed perfectly white; but it is a curious coincidence that the defect is very similar in quality to that of a well-corrected (*i.e.*, in technical language, *over-corrected*) achromatic, a portion of the blue rays being in either case separated, and so giving a slight complementary orange tint to the remainder. The difference, however, is that in the achromatic they are visible, and with high powers obtrusive, as a luminous fringe; in the silver film they disappear from transmission, so as to leave the image clean.

Occultation.—July 11th. η Libræ, 6 mag., 10h. 15m. to 11h. 25m.

ON THE EGGS OF CORIXA MERCENARIA.

BY DR. T. L. PHIPSON, F.C.S.,

Member of the Chemical Society of Paris, etc.

The eggs of the Mexican insect *Corixa mercenaria* (Say), are interesting, in the first place, because they form an aliment extensively used by man; in the second, inasmuch as they contribute to the oolitic structure of certain fresh water limestones of modern formation. In speaking of this insect production in another place,* I stated with regret that these eggs had not yet been submitted to chemical analysis. When the Mexican traveller, M. Virlet d'Aoust, returned to Paris, he placed in my hands a certain quantity of them, but the greater portion I also distributed among my friends. Recently I have examined, microscopically and chemically, what remained of my specimen, and though the quantity was very small, some unexpected results have been obtained.

For ages the Mexicans have consumed great quantities of these eggs; they find them strewed by millions upon the reeds which grow on the banks of the great fresh-water lakes Texcocco and Chalco. The mode of collecting them is very simple; they are shaken from the reeds into a cloth, and set to dry in the sun, after which they are ground like flour, placed in sacks, and sold to the inhabitants, who make the flour into a kind of cake called *hautlé*. The eggs themselves are spoken of as *Agautle*, and before being ground are used to feed chickens.

It was interesting to ascertain by analysis whether this substance is more or less nutritious than our bread, and, at first sight, it would appear to be infinitely more so.

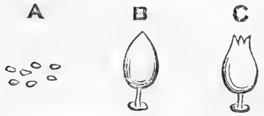
* *The Utilization of Minute Life*, p. 104.

The eggs given to me by M. Virlet were in the state in which they are usually collected. They had been dried in the sun, but not ground, so that their microscopic structure could be examined as well as their chemical composition.

First, with regard to the latter, they have yielded me:—

Water	0·8
Mineral matter	5·0
Organic matter, consisting almost exclusively of Chitine	94·2
	100·0
Nitrogen (per cent.)	6·2

The mineral matter, or ash left after incineration, contains much phosphate of lime, it contains also carbonate of lime, oxide of iron, soda, and silicic acid. The quantity of material in my possession being so small, precluded the possibility of a quantitative analysis of the ash. The organic matter, amounting to 94·2 *per cent.*, consisted almost entirely of Chitine; this curious fact was fully explained when the eggs were submitted to microscopical examination.



A. Natural size.
B. Magnified.
C. The egg after exit of the larva.

It was found that the *larvæ* had quitted them. Nothing remained but the rigid envelope of the egg, and its singular little appendix, by which each egg adheres to the surface of the reed. (See Fig.)

Under the microscope, with one quarter inch object-glass, the eggs of the *Corixa* do not differ in appearance from those of a chicken, but underneath the wider extremity of the egg exists a little appendix, in shape like the foot of a wine-glass, which I do not find mentioned in any work on comparative anatomy, and does not seem to have been observed before. The oval portion of the egg appears to be formed of Chitine and mineral matter containing much lime. The little appendix is formed of Chitine alone, and under the microscope appears like ordinary gelatine. The larva leaves the egg by a circular stellated orifice formed at its narrow extremity.

From what precedes, it would appear that the flour formed by grinding these eggs of the *Corixa* must be of a most nutritious nature:—The amount of nitrogen found in the analysis is very large, and agrees nearly with the known composition of Chitine. For it is impossible to admit with M. Fremy that Chitine is a substance analogous to cellulose. In his experiments upon the former, he boiled it with solution of potash, in order, as he stated, to eliminate the albuminous compounds which he supposes associated with it. It is very much more probable that

Chitine is a glucoside $C^{18}H^{15}NO^{4}$, yielding glucose and lactamide (or some such body) by the action of mineral acids, and boiling with caustic potash decomposes it easily.

But the Editor of this journal has called my attention to the fact, that *Chitinous* substances are known to be very indigestible, so much so, that the chitinous parts of insects are frequently present in the excreta of insectivorous animals; and this would tend to prove that, in spite of the large amount of nitrogen yielded in the analysis, and the fact of the insect flour being baked into cakes, the highly nutritious quality of the latter may be reasonably doubted.

In our climate we have representatives of these Mexican boat-flies in our genus *Notonecta*. Indeed, three species of insects appear to contribute to the formation of the Mexican flour *hautlé*, namely *Corixa mercenaria*, *C. femorata*, and *Notonecta unifasciata*. The first is the most plentiful, the latter is the largest of the three, and resembles our common boat-flies.

This peculiar insect product, which serves as an aliment to a large proportion of the inhabitants of Mexico, was mentioned by the English naturalist, Thomas Gage, in 1625.

M. Virlet has assured himself that the white limestone rock which is forming at the present day in the fresh water lakes Texcocco and Chalco, owes its oolitic structure to the presence of these eggs of the *Corixa* and *Notonecta*. I have observed a very similar structure in the red hematite of Namur (Belgium), and also in a red hematite from Illinois (North America); but the oolitic limestones of the Jura series appear to have a different origin.

ARCHÆOLOGIA.

In the Antonine Itinerary, on the line of road between Calleva (*Silchester*) and Venta Belgarum (*Winchester*), both of them towns of importance, we have a station bearing the name of Vindomis. It was fifteen (Roman) miles from the former place, and twenty-one from the latter. It was evidently a small place, and had left so little trace behind it, that antiquaries were disagreed as to where it stood. Sir Richard Colt Hoare seemed to have given substantial reasons for supposing that the site of Vindomis must be sought at a place called Finkley Farm, close to the old London road, not far from Andover, in Hampshire, and he fixed the exact locality to a spot called Nettle-field, the very name of which would lead us to conclude that it had been ground covering ruins, and therefore out of cultivation, and he had, in fact, obtained from the ground some fragments of Roman pottery. It has proved that Sir Richard Colt Hoare was very nearly correct in his conjecture. On the other side of the road, separated by about two field-lengths from Nettle-field, is a rather boldly-rising elevation, called Tinker's Hill, to which the attention of a gentleman of antiquarian zeal in the neighbourhood, Mr. Charles Lockhart, was attracted by the much more frequent discovery of Roman remains, especially in a field which was named Castle-field, and calling in the assistance of the Rev. E. Kell, F.S.A., they proceeded to excavate. The immediate result was the discovery of a building of considerable dimensions, and of undoubted Roman workmanship. At the last meeting of the Archæological Association, on the evening of June 12, Mr. Kell read a paper giving a detailed account of this discovery. The building, the foundations of which were thus brought to light, consisted of a large room, forming a parallelogram, sixty-six feet six inches in length, and forty-one feet two inches in breadth, lying in a direction not quite east and west, and having in the centre of its eastern end, on the exterior, a much smaller room attached, measuring twenty-two feet two inches in length, by fourteen feet in breadth, which Mr. Kell calls a portico. The large building, which had evidently formed only one apartment, appeared to have had a roof, supported upon two rows of pillars, the bases of which remain, and which were arranged in two rows of seven each, running in a line with the side-walls of the portico. The bases of the columns were four inches long by thirteen inches wide. A large number of the ordinary Roman roofing slates, hexagonal in shape, were found scattered about the building, the nails which held them together remaining in some of them. The floor was simply pitched over with flint stones. There were found distributed on the floor four stones, or rather, as we understand it, large clay tiles, two feet long by sixteen inches broad, artificially laid, which appeared to be intended for places for fires, for their surfaces had been blackened by the burning. There were also found constructions to which Mr. Kell gives the name of furnace, placed in a regular manner at the western end of the room, towards its centre, which Mr. Kell sup-

poses to have been used for culinary purposes, as well as for giving warmth. He describes the most perfect of them as being "a round hole, five feet deep, the sides perpendicular to the bottom." It was thirty-two inches in diameter. "The bottom was paved true all over with stones laid in red clay, the upper side of the stones coloured from the effects of fire." The western portico had had two columns, one on each side, arranged in a manner to leave little doubt that it had been the entrance to the building. No other remains of masonry were found in the vicinity of this building, so that it appears to have stood solitary by itself, close to the Roman road. Within the building, and on the surface of the field outside, were picked up seven or eight fragments of Samian ware, and a considerable quantity of other pottery, the half of a quern, some fragments of glass of several colours, a few objects in metal, of no great interest, and a few Roman coins, the latter chiefly of third brass, and of the later period of the Roman empire in the West.

We feel convinced that Messrs. Lockhart and Kell are correct in identifying the ruins they have discovered on Tinker's Hill with the Vindomis of the Antonine Itinerary, which was no doubt one of the Roman *stations*, or halting-places on the road. On the subject of these *stations*, the reader may be referred to an excellent paper by Mr. C. Roach Smith, in the fourth volume of his valuable *Collectanea Antiqua*, in which he describes one of these establishments, the massive walls of which still remain standing at the village of Thésée, between Tours and Gièvres, in France. They were sufficiently commodious for lodging troops on a march, and for all the purposes of a large posting inn, being furnished with provisions for men and horses, with carriages, and with other necessaries, the allotment and distribution of which were under the inspection of the Government agents, who were controlled by strict legal enactments. This *statio* at Thésée, which is the *Tasciaca* of the Itineraries, is of considerably larger dimensions than that of Vindomis, which we might probably expect, from the difference of these two provinces. The two great cities of Calleva and Venta were only thirty-six Roman miles apart, so that no *statio* of any great magnitude could be wanted on this road between them. In a country like Britain, where the ground has been so highly cultivated, and where the remains of the Roman period have experienced so great destruction, we need not be surprised if no Roman *statio* has been previously discovered, and we are inclined to consider this of Vindomis as the only one of which the remains have yet been traced. The remains discovered by Mr. Roach Smith, at Hartlip, in Kent, and by the late Lord Braybroke, at Ickleton, with which Mr. Kell would compare it—especially the former—were villas, or country mansions, and belonged to an entirely different class. Both Mr. Kell and Mr. Lockhart deserve great commendation for the zeal and judgment to which we owe so interesting a discovery.

Attention has recently been called to the remarkably fine and interesting NORMAN CHURCH at ST. MARGARET'S-AT-CLIFFE, near Dover, and the incumbent, the Rev. E. C. Lucey, is making very meri-

torious efforts for its restoration. It is one of our finest examples of the Norman ecclesiastical architecture of about the middle of the twelfth century. The true character of the church has only been discovered of late years, by the removal of the thick coating of white-wash and other modern applications, which entirely concealed its most beautiful features, and there remains still much work of great interest and beauty which is entirely or nearly concealed from view. Among these hidden or obscured beauties is a very fine early English arch, leading from the nave to the tower, which is at present blocked up with a very ugly white-washed screen and organ loft.

The archæological part of the EXPOSITION UNIVERSELLE, which is at this moment drawing such numerous and distinguished visitors to Paris (in the midst of whom we are at this moment writing), presents some very interesting features. They are chiefly exhibited in that part of the Exhibition which is devoted to the *histoire du travail*, occupying a considerable part of the inner gallery of the building. The interest of this class has been much increased by the care which has been taken to arrange the objects in chronological order. The collection of prehistoric remains of all the countries of western and northern Europe is particularly full and striking, and we can, with great advantage, not only compare the various objects found in this country, but make a separate comparison of those of one country with those of another. The collection of prehistoric remains from Denmark is especially rich. The prehistoric remains found in France by Messrs. Christy and Lartet form a special feature in this part of the Exhibition, and the most interesting case in it is that containing the bones and stones of the "prehistoric period" bearing drawings of animals and other objects, in rude outline, but sometimes very well drawn. This comprehensive examination of them confirms the opinion we have always entertained that these curious monuments are not of the immense antiquity claimed for them. An examination of these numerous cases filled with stone implements will show us to what a great variety of uses stone was applied in rude, and even in comparatively late ages, and also, we can hardly help being convinced that many of these stone implements were made by people who took instruments made of metal as their models. The collection of bronze instruments is richest in those brought from northern Europe. The antiquity of these bronze objects, as well as of the pottery which is ascribed to the prehistoric period, appears to us to be greatly overrated. Much of this early pottery presents a very different character of design and workmanship from that found in our island. We may draw attention, among a crowd of interesting objects, to a bronze helmet and sword belonging to the Museum of Narbonne, which we are more inclined to look upon as belonging to the period of the fall of the Roman empire in the west, than as absolutely prehistoric. There is a good collection of Roman antiquities, among which may be pointed out some examples of tools and implements which are extremely curious. A Roman chariot from Toulouse is also very remarkable, and there is a peculiarly fine collection of large funerary urns, some of a nearly globular

form, and one of a very remarkable character, of Samian ware, apparently of the very late Roman period. The collection of early Frankish and Germanic antiquities is also most interesting, and is well worthy of study—especially some of the Frankish weapons, in iron, such as swords, battle-axes, spear-heads, and bosses of shields. The remains of the Christian Frankish age are also rather numerous, including some fine examples of coffers and reliquaries, and some exceedingly interesting specimens of early enamel. The continuous museum of mediæval art and workmanship in the Exhibition building is very complete, and is arranged with judgment in its different historic periods. Each is rich in its peculiar illuminated manuscripts, in its sculptured ivories, and in an infinite variety of objects, which it would be quite impossible even to enumerate here, and it would be difficult, without much more space at our disposal, to make even a selection. The show of early enamels of Limoges is something wonderful. T. W.

PROGRESS OF INVENTION.

New Photographic Instrument.—An ingenious apparatus, termed by the inventor a Photographometer, and intended to record the angular position of objects situated around a given point, has been constructed by M. Chevallier. It is entirely automative, and very simple, so that it may be used by those possessing but little manipulative skill. The record is made by photography, and the camera used, with the exception of certain additions, does not differ much from the ordinary kind. The objective, which is that usually employed by photographers, is mounted vertically on a circular platform capable of rotating, by means of clockwork, in a horizontal plane. The picture is formed, not in a vertical plane, as in ordinary cases, but in a horizontal; and therefore the rays passing in through the objective are deflected 90° by means of a reflecting prism, so as to fall on the sensitive surface, which is collodionized glass, and is placed in such a way that its centre corresponds with the point at which the centre point of the diaphragm would be represented. To prevent a number of confused images, superimposed on each other, being formed during the rotation of the objective, an opaque screen, having a narrow oblong opening, the median line of which passes through the axis of rotation, is placed over the whole of the sensitized surface, and revolves along with the objective. The result of this arrangement is the production on the sensitized plate of images of the different points that lie around the observer; the angles formed by lines joining the centre of the plate, and the different objects being exactly the same as those formed by lines joining the centre of the instrument, and the objects themselves. It is evident that the position of the objects thus accurately obtained may be transferred to paper, etc., in the ordinary way. As different velocities of rotation may be suited to different purposes, three different velocities may be obtained by means of a regulator. And

as it may be wished to mark down only certain points of the panorama, an arrangement is made which secures the attainment of this object. Should it be desired to observe not different points, but successive changes at the same point, the objective and the screen are disconnected, so that only the latter revolves; the successive appearances at the same point are then recorded in succession in a circle round the sensitized plate.

Compound Pipes.—To obviate the dangers which, especially in certain circumstances, have been found to attend the use of leaden pipes, and at the same time to secure the cheapness and other good qualities of lead, a very simple mode of forming pipes, consisting externally of lead, but internally of a thin shell of tin firmly attached to the lead, has been invented. The cylinder of which the pipe is to be formed, by drawing, is externally of lead, but internally of tin, both being firmly united together, and the relative thicknesses of the metals being such, that when the lead is drawn to the proper length, the coating of tin will be of the desired depth. The tin, which very slightly augments the cost of production, will remain entire, however thin the pipe may be, if ordinary care is taken.

Clearing of Ships from Bilge Water or Leakage.—A very simple mode of effecting this is coming into use on the rivers of the Western States of America. It is founded on the principle of Giffard's injectors, and consists in placing in the vessel to be emptied a pipe, in ordinary cases, about two inches in diameter, with one extremity reaching to very nearly the bottom of the hold, and the other projecting through its side a little above the water line. Then inserting the conical extremity of a small pipe leading from the steam boiler, and fitted with a stop-cock, into the end next the bottom of the vessel. If water reaches above the lower end of the larger pipe, turning on steam into the smaller will cause the water to be carried off with great velocity. It is not necessary that the steam boiler should be in the vessel which is to be cleared of water. The steam vessel may be alongside of the barge, etc., which is to be emptied, and the larger pipe may be laid down temporarily, the upper end being merely turned over the side: and steam may be conveyed to the conical nozzle inserted in the lower end of the larger pipe by means of a small flexible pipe leading from the boiler of the steamer.

Economic Production of Oxygen for Industrial Purposes.—Oxygen is now obtained very economically by decomposition of sulphuric acid. This is effected by means of heat, and an apparatus devised for the purpose. The acid is decomposed into oxygen and sulphurous acid, and the latter is removed by liquefaction, effected by pressure. The sulphuric acid employed is not wasted, it is merely the vehicle for obtaining oxygen from the atmosphere, and may therefore be employed over and over again, the sulphurous acid being, after each operation, changed back again into sulphuric acid in the usual way. A kilogramme of sulphuric acid at 60° affords a cubic metre of oxygen.

Modification of the Pneumatic Despatch.—The Pneumatic despatch, as organized at Paris, differs in some points, and advan-

tageously, from that used in this country. The motive power is compressed air, the compression being produced by means of the water supply, which, in Paris, is highly effective, the head of water being very considerable. Water being let into one tank, the air expelled from it by the water is transmitted to an air tank, of which there is one at each extremity of the line. Each of the tanks is of iron plate, and holds about one thousand gallons. The time expended in filling the water tank is about three minutes, and the air thus expelled from it is more than enough to propel the waggon along the entire line, which is about two miles in length. The waggon is of a peculiar form, being a hollow piston about five and a half feet long, closed permanently at one end, and temporarily by a movable lid at the other. Leather washers placed around the closed end, fill up the space between it and the pneumatic tube, which is two and half feet in diameter. The signals between the stations are made by electric bells; the waggon announces its approach by the noise which it makes. When it is to be sent off, it is placed in the mouth of the tube, which is then put in connection with the compressed air, the other extremity being put in connection with the atmosphere, that the air in front of the waggon may have a means of escape. This system is very simple, economic, and effective, but it is applicable only where the head of water is great. In Paris it is very considerable, and a pressure is therefore produced by it which affords a motive power applicable to a great number of useful purposes.

Utilization of the Electric Light.—The brilliant light afforded by electricity naturally suggested, at a very early period, its application to the purposes of illumination. But every project for the purpose was practically impossible, until very great progress had been made in the modes of producing and manipulating that obtained by means of the pile, or the magnet. Galvanic electricity, which in its application preceded that derived from magnetism, appears not unlikely to maintain its ground as a convenient and economic source of light, notwithstanding the numerous and important discoveries that have been made in this department of science. This might fairly be expected: since, at least in those contrivances in which heat and light are the results of the transformation of motion—previously obtained directly from combustion—the effect must be more costly and complicated than when obtained directly from combustion, as is the case with galvanic electricity. The effects produced by the latter is now so economic, and what is still more important, so reliable, that it is being introduced with excellent effect in France, as a means of diffusing to great distances a light so intense, that when it is used, collision at night is impossible. Also, during the intense frosts in January, the skaters in the Bois de Boulogne were enabled, by means of fifteen electric lights, suitably disposed, to enjoy their pastime by night, with at least as much convenience and security as by day. Each of the fifteen lights was produced by the electric current obtained from a Bunsen battery containing forty elements, and placed in a small closed pit, from which the vapours were conveyed away, so as to be the cause of no incon-

venience to those in the vicinity. The carbon points lasted for several hours, affording a light practically uniform; and when they were nearly worn out, a fresh lamp, moving on rails provided for the purpose, was slid into the place of that which was exhausted. In taking its position, it lit of itself: and the displacement of its predecessor caused the worn out points to be extinguished, the change taking place so quietly, and so rapidly, that no interruption of the light was perceptible. A single additional lamp is sufficient to change the fifteen at the proper times, the points being so arranged as to become exhausted in succession.

New Mode of Dissolving Vegetable Fibre.—Various solvents for dissolving vegetable fibre are known; but, besides being most unusually expensive, some of them give rise to explosive compounds. It is found, however, that it is readily dissolved by a strong solution of ammoniated copper. Filtering paper, probably on account of the processes employed in its manufacture, dissolves easily, and without residue, in the cupreous solution. The vegetable fibre is thrown down from the solution thus obtained, as a gelatinous precipitate, by boiling, exposure to the air, or the addition of an acid. The ammoniated sulphate will take up so much of the filtering paper as to form a viscid adhesive mass.

PROCEEDINGS OF LEARNED SOCIETIES.*

ROYAL MICROSCOPICAL SOCIETY.—*June* 12.

Dr. Arthur Farr, F.R.S., V.P.R.M.S., in the Chair.

Dr. Carpenter, F.R.S., gave an interesting account of a binocular microscope by Nachet, which, though less optically perfect than Mr. Wenham's, enabled the cone of rays ordinarily passing to the right eye to be transferred to the left, and the left cone to the right, by pulling out a slide containing the prisms. The effect of this is to convert the instrument into a *pseudoscope*, and to make elevations look like depressions, and *vice versâ*. Dr. Carpenter gave many important illustrations of the principles of stereoscopic vision, and said that to obtain true appearances the angle of aperture of objectives must be moderate in proportion to their focal length. For a half-inch objective he found 40° gave excellent results, and this corresponded very closely with theoretical calculations.

He likewise described a dissecting binocular microscope by Nachet, which he praised highly. The larger instrument had an excellent and very simple mechanical stage—a rotating movement, something like Smith and Beck's "Popular," and other motions made by the hand, and regulated by spring attachments of a glass object-carrier to a glass stage.

Professor Rymer Jones described the wonderful changes that occur in the larvæ of the *Corethra plumicornis*, which he illustrated

* The most important subject that has lately come before the Royal Society will be found in the article on the "Recent Discoveries of Mr. Graham."

by large beautifully-executed diagrams. It appears that the air sacs, which are so conspicuous in this elegant object, suddenly expand, and occasion the development of a complicated trachæal system. The mouth organs and internal structure of this larva were also illustrated in the professor's paper.

Mr. Browning described the spectra obtained by reflected light, from the dichroic fluid, shown at the previous meeting by the Rev. J. B. Reade, and explained that it differed very curiously from that given by transmitted light, part of the yellow being replaced by green.

LITERARY NOTICES.

Physical Geography, by Professor D. T. Ansted, M.A., F.R.S., F.R.G.S., F.G.S., Honorary Fellow of King's College, London, and late Fellow of Jesus College, Cambridge. (W. H. Allen and Co.)—We intend to take an early opportunity of noticing this work at greater length, and will now only observe that Professor Ansted has produced an admirable book adapted to the wants of students, whether in colleges or private families. For general reading it is the best work of the kind that we are acquainted with, being written on a comprehensive plan, and in a clear and elegant style. Without any parade of scientific learning, the Professor has brought together in good logical array an immense mass of information, laying his foundation on astronomical considerations of our earth as a planet, and then examining in succession the various causes which have modified its surface, and occasioned the existing distribution of land and water. Atmospheric influences and climate are also well treated, and the work ends with a description of the changes effected by human agency. One great merit of this method of treatment is that the philosophy of the subject is naturally unfolded, and the student is pleasantly and insensibly led from simple elementary facts to those grand generalizations which emphatically constitute science, properly so called.

Archives of Medicine: a Record of Practical Observations, and Anatomical and Chemical Researches connected with the Investigation and Treatment of Disease. Edited by Lionel S. Beale, Vol. IV., No. xvi. (Churchill.)—In addition to notes of cases treated at King's College Hospital, this number contains several important papers. Mr. J. Lockhart Clarke describes a case of paraplegia resulting from a cancerous growth affecting the spinal cord, and Dr. Bateman describes a fatty tumour as big as an egg which grew in the cerebellum of one of his patients. It induced a staggering gait, a jerking spasmodic method of speaking, and partial loss of sight and hearing. Intelligence was unimpaired and memory good. Dr. Morris Tonge describes a case in which fungi were developed in the kidneys; and other papers will well repay professional perusal.

Photographs of Eminent Medical Men of all Countries, with brief Analytical Notices of their Works. Edited by W. Tindal Robertson, M.D., M.R.C.P., Physician to the General Hospital, Not-

tingham, the Photographic Portraits from Life by Ernest Edwards, B.A., Cantab. No. 2, Vol. II. (Churchill).—The present part is devoted to Dr. Carpenter. F.R.S., Mr. N. B. Wood, F.R.S., and Dr. Robert Uvedal West. The portraits are very good, and the letter-press affords a compendious sketch of the biography of their originals. We have no doubt this series will be widely appreciated.

A Handy Book of Meteorology, by Alexander Buchan, M.A., Secretary of the Scottish Meteorological Society. (Blackwood and Sons.)—This is a nicely-arranged and comprehensive treatise, illustrated by woodcuts of apparatus, and five meteorological charts. As the Government have very unwisely suspended the storm-warnings commenced by the late Admiral Fitzroy, we are glad to cite the following sound practical opinion:—"The truth is, no prediction of the weather can be made, at least in the British Islands, for more than three, or perhaps only two days beforehand, and any attempt at longer prediction is illusory. The principles laid down in the chapter on storms show the possibility and mode of making real predictions. Thus, if from telegrams of the weather it appears that barometers are everywhere high over Europe, then no storm need be dreaded for two days at least. That if on the following morning barometers begin to fall in the west of Ireland, and easterly winds blow over Great Britain and Norway, and south-easterly winds over France, it is likely that a storm more or less severe is approaching the British islands. The indications ought now to be closely watched by the telegraph; and if the winds veer towards the south and west, and increase in power, and barometers in Ireland fall rapidly, a great storm is portended, the approach of which should be telegraphed at once to the seaports threatened by it. But if, on the contrary, barometers fall slightly, or cease to fall, and the winds do not increase in strength, the storm has either passed considerably to the north of the British islands, or its approach is delayed, and no immediate warning is necessary."

English Prose Composition: a Practical Manual for the Use of Schools. By James Currie, M.A., Principal of the Church of Scotland Training College, Edinburgh. (Blackwood and Sons.)—The notion of this work is very good, and the execution generally satisfactory, but some of the critical remarks need correction. For example, citing—

> "Then shall love keep the ashes and broken parts
> Of both our broken hearts,"

as a specimen of "forced, unnatural, and obscure expression," is scarcely just. There is not the least obscurity to any one who remembers the practice of collecting in memorial urns ashes and osseous fragments from the funeral pyre. The objection to the figure is the confusion of thought involved in the "broken parts" and "broken hearts," the one somewhat clumsily referring to the incidents of cremation, and the other to a purely figurative "breaking." The broad, unqualified statement, that "mixed figures should be avoided, as detracting both from clearness and beauty," is not justifiable, as some fine passages from great authors could be

cited, in which mixed figures have been advantageously employed. In Ben Jonson's famous poem beginning "Truth is the trial of itself," we have the following verse:—

> "It is the warrant of the word
> That yields a scent so sweet,
> As gives to faith its power to tread
> All falsehood under feet."

Here the figures are ably and elegantly mixed. The real objection to what Mr. Currie calls "mixture" is, the juxtaposition of figures that will not *mix*, by reason of their incongruity, as in the instance he gives—"There is not a single *view* of human nature which is not sufficient to *extinguish* the *seeds* of pride"—a sentence which looks like a bit of a leader from the *Telegraph*. On the whole, we like the book, though we should object to making "paraphrasing," a prominent part in any system of teaching. If good authors are selected for this process, the pupil is simply taught to say a good thing in a worse manner than it has been said before.

First Steps in Geography; Geography of the British Empire. Both by the Rev. Alexander Mackay, LL.D., F.R.G.S., author of "A Manual of Modern Geography," etc. (Blackwood.)—We do not believe in threepenny and fourpenny geographies—not that we have any objection to articles of low price, if it is possible to make them good for the money; but "First Steps in Geography" in fifty-six very small pages must necessarily be very dry and very incomplete. The simpler elements of physical geography should be taught first, and political geography at a later period, if the pupils are to be interested in the study, and to gain ideas instead of mere words. At the second page of "First Steps" we find a wrong step taken, and a false idea given. The writer says, speaking of the oceans, "They are not *entirely* separated from each other, like the continents"—thus giving an erroneous notion of the continents of which Europe, Asia, and Africa are three portions of one great continent, and not as distinct as the passage cited would convey.

NOTES AND MEMORANDA.

Bromide of Potassium in Epilepsy.—M. Namias states in *Comptes Rendus* that bromide of potassium, beginning with one gramme taken during the day in three doses, and increasing it to several grammes in twenty-four hours, diminishes the violence and the number of epileptic attacks.

Weakness of Wheat Stems.—M. Velter examines, in *Comptes Rendus*, the cause of that weakness of wheat stems which allows the plant to be laid by wind and rain. He remarks that M. Pierre had shown that laid wheat often contained more silica than that which remained standing, and his own experiments led him to consider a manure of silicate of potash mischievous. He says that wheat becomes laid not for want of silica, but because the ligneous matter of the straw is not well developed. He also states that a microscopic examination shows the deposit of silica to be discontinuous, and not to form a compact framework.

Ophthalmic use of Sulphate of Soda.—M. D. de Lucca states (*Comptes Rendus*) that the powder of crystallized sulphate of soda dropped in small quantities on the cornea, and allowed to dissolve in the fluids of that organ will, in the course of time remove opaque spots.

THE CRATER LINNÉ.—M. Chacornac sees divergent rays like the glory of a saint round this object. P. Secchi writes to the French Academy that Professor Respighi and his assistant, P. Ferrari, of the Capitoline Observatory, Rome, find that with a power of 500, which diminishes irradiation, a funnel-shaped cavity can still be discerned, so that the lower cavity has not disappeared, although the crater is very flat. This appears to correspond with the statement of the Astronomer Royal in his recent report to the Board of Visitors, "that drawings of the spot Linneus on the moon leave no doubt that it is still a very shallow cup."

THE OPALS OF CALIFORNIA. It is stated in *Cosmos* that the Californian opals are found in ancient decomposed lavas, and that the matrix of the gem is saturated with water, and the opals themselves soft enough to break between the fingers when first dug. Exposure to the sun for several days hardens them and brings out their lustre. The best are enveloped in a ferruginous crust, while those which are white and of feeble colour are without this covering.

OBSERVATIONS ON CHLOROPHYLL.—M. Marc Micheli has a paper on this subject in the *Archives des Sciences*, and he thus sums up his conclusions: 1. There is not sufficient proof to admit Frémy's hypothesis, that chlorophyll is decomposable into phyllocyanine and phylloxanthine. 2. Chlorophyll appears to be formed of a yellow substance, which transforms itself into a green one in a manner which is unknown. 3. All acids destroy the colour of chlorophyll, and turn it yellow. 4. Two of them, SO_3 and HCl, possess the property of changing this yellow into blue or green, according to which is employed, and baryta acts in an analogous manner. 5. Light does not discolour the green and blue obtained by SO_3 or HCl; it is not therefore the same colour which is found in chlorophyll. 6. Many leaves become transparent in full sunshine, an effect which seems to arise from the contraction of the chlorophyll granules.

EHRENBERG ON THE HYALONEMA.—The *Annals Nat. Hist.* contains a translation of a paper by Professor Ehrenberg, on the *Hyalonema Lusitanicum*, discovered by Professor Borboza da Bocage. His conclusions are that the Hyalonema is not a polyp, but a sponge. He considers, which can scarcely be justified by facts, that the essential character of sponges coincide with that of vegetable bodies, and he imagines the "supposed normally protruding tufts of Hyalonema, when they occur on true sponge structures, to be mutilations by the loss of the apices of those sponges, like the dead points of horny corals, just as the deciduous trees in the north, or on elevations, often bear antler-like dead summits, while the trunk is still well furnished with foliage."

THE MOTOR CLOCK OF THE GREENWICH OBSERVATORY.—The following passages occur in the report to the visitors: "this clock is compared and verified by an easy practical process. It maintains various clocks in sympathy with itself, it regulates clocks in London, sends signals through Britain, drops the Deal time-ball, fires guns at Newcastle and Shields (I think also at Sunderland), and puts communications in such a state that we can receive automatic reports from the signal-places as we may desire. I may, however, specially mention that daily signals are now sent to some places in Ireland; and that, during the expedition of the Great Eastern for laying down the Atlantic cable, time signals were sent on board twice a day, to enable her constantly to determine her longitude."

THE HOUSES OF PARLIAMENT CLOCK.—The Astronomer Royal reports that on 38 per cent. of the days of observation, the clock's error was below 1^s; on 38 per cent. of days of observation, between 1^s and 2^s; on 21 per cent., be ween 2^s and 3^s; on 2 per cent., between 3^s and 4^s; on 1 per cent., between 4^s and 5^s.

ARTIFICIAL RESPIRATION AND STRYCHNINE.—M. J. Rosenthal states, in *Comptes Rendus*, that by exciting artificial respiration, and maintaining it for three or four hours, it is possible to save the life of an animal to which a poisonous dose of strychnine has been administered.

INDEX.

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